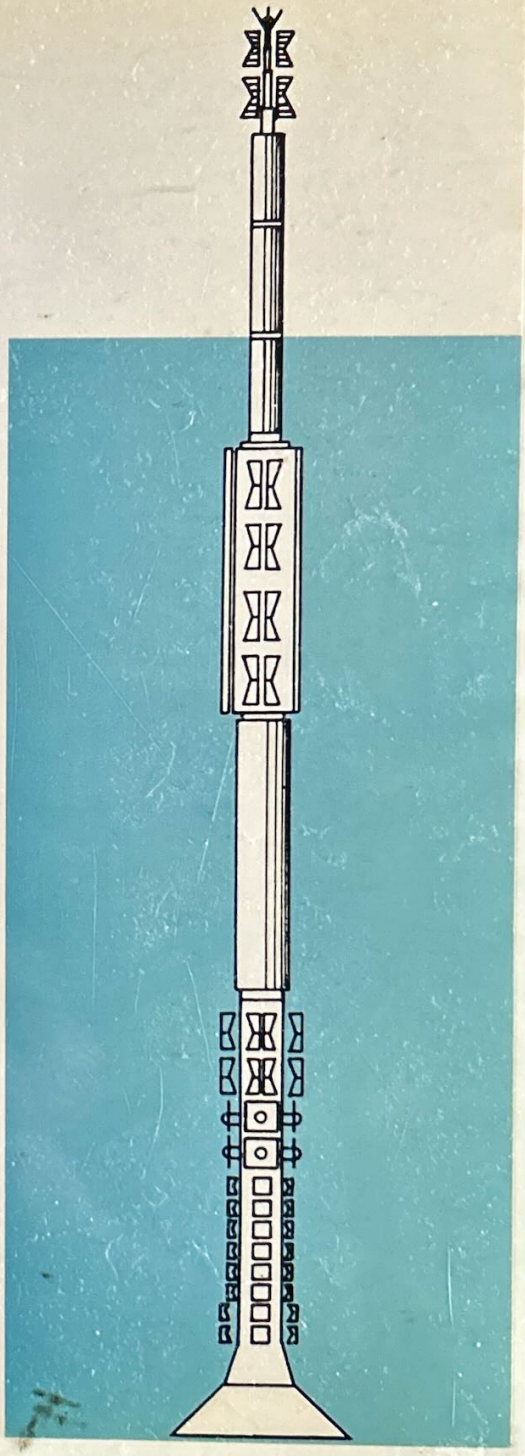
RCA

Proposal to
The Port of New York Authority
New York, N.Y.

TV and FM Antenna Array for The World Trade Center



Volume II

ICEN
WTC
BND

VOL 2

SPEC

RCA PROPOSAL BC-02636

Submitted To

THE PORT OF NEW YORK AUTHORITY

New York, N. Y.

ERRATA

1. Volume I, Section III, Page 1:

   Add the following to the addendum list-

   "Addendum No. 8 (June 24, 1970)

   Addendum No. 9 (June 29, 1970)"

2. Volume I, Section VI, Page 2, paragraph entitled "Support By The Authority", Line 3:

   Add a period following the word "proposal" and delete the words "dated June 19, 1970."

3. Volume II, Section VII, Appendix 6, Index, last line:

   Change "Table 1-7" to read "Table 1-11".

4. Volume II, Section VII, Appendix 7, Page 1, Line 3:

   Change power gain from "5.1" to read "5.3".

5. Volume III, Section IX, Page 1:

   Add the following to the addendum list-

   "Addendum No. 8 (June 24, 1970)

   Addendum No. 9 (June 29, 1970)

SECTION VII
Appendix 2 TV, Ch. 4
Appendix 3 WNEW-TV, Ch. 5
WABC-TV, Ch. 7
WOR-TV, Ch. 9
WPIX-TV Ch. 11

6. Volume III, Section IX, Appendix 8, Figure 1-31:
   Change "El. 240.1" to read "El. 170.1".

7. Volume III, Section IX, Appendix 9, Table 1-41:
   Add in "Remarks" column of Line 2 entitled "Vertical Power Gain at Horizontal", the words "For 1.5° Beam Tilt Direction".

8. Volume III, Section IX, Appendix 10, Table 1-47:
   Add in "Remarks" column of Line 2 entitled "Vertical Power Gain at Horizontal", the words "For 1.5° Beam Tilt Direction".

9. Volume III, Section IX, Appendix 11, Page 1, Last line:
   Delete period following last word and add-
   ", except last paragraph in Page 8 (Helicopter Measurements)."

10. Volume IV, Section X, Appendix 1, Table 3-2:
    Change Specification for Isolation from Channel 31 from "-10 dB" to "-31 dB".

11. Volume IV, Section X, Appendix 3, Table 1-5:
    Change figure following "Vertical Power Gain, Main Lobe" under "DB" column from "2.79" to "3.01".

12. Volume IV, Section X, Appendix 6, Table 2-11:
    Change figure following "Vertical Pattern Dwg. No." from "PBK-050670-L" to "PBK-050670-C".

13. Volume IV, Section X, Appendix 8, Table 1-31:

Change figure following "Beam Tilt" under "VALUE" column from "0.9" to "2.0".

14. Volume IV, Section X, Appendix 11, Table 1-FM:

Change MI number following "Input Line Size and MI No." under "Remarks" column from "MI-27792-D" to "MI-27791-D".

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TELEVISION AND FM ANTENNAS,

SUPPORT TOWER AND TRANSMISSION LINES

FOR THE WORLD TRADE CENTER

RCA PROPOSAL BC-02636

Submitted To

THE PORT OF NEW YORK AUTHORITY

NEW YORK, N. Y.

Bid Specs

Appendix 1 WNBC-TV Ch. 4
Appendix 2 WNEW-TV Ch. 5
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Appendix 5 WPIX-TV Ch. 11
SECTION VII

BC-02636

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VII. SPECIFICATIONS

A. Introduction

This section of the proposal contains RCA's response to the requirements for tower, antennas and related transmission line systems as set forth in Chapter II - SPECIFICATIONS.

The arrangement of antennas on the support tower is shown as Figure A following this introduction. The configuration of the tower alone follows as Figure B.

The support tower and accessory items are commented on in Part G of this section. Additional information may be found in Section IV of this proposal.

Under Part D of this Section VII, in a separate Appendix for each station, are included a pictorial description of the antenna and line, necessary technical data, and a description of auxiliary items required, as well as an explanation of the tests and measurements to be made at the development site and at the point of installation.

It will be noted that in the cases of Channels 2, 7, 9, 11 and 13, a number of the main and standby antenna characteristics set forth are considerably better than those requested. These are inherent in the design and do not represent added cost, but are

given here to aid in evaluation of the proposal. They may be summarized as follows:

Channel 2 The horizontal pattern circularity required is ± 2.0 db. The antenna being offered will have a circularity better than ± 1.0 db. This has been verified by actual model pattern measurements.

Channel 7 A horizontal pattern circularity of ± 1.1 db is being offered for the main antenna as contrasted to a required value of ± 1.5 db.

Channel 9 No antenna input specification has been defined in the request. However, from previous experience, RCA anticipates that VSWR values across the channel for the main (diplexed) antenna will be below 1.08 to 1.0.

An RF pulse of 2.5% for the system is proposed, where 3.0% is the required value.

Channel 11 A horizontal pattern circularity of ± 1.1 db is being offered for the main antenna as contrasted to a required value of ± 1.5 db.

Channel 13 Same as for Channel 9. In addition, a gain of 5.3 or better is expected, as contrasted to the required minimum of 4.9.

Standby Antennas (Channels 7, 9, 11 and 13)

While no antenna input VSWR is stipulated as a requirement, a value of better than 1.05 to 1.0 across the channel is expected.

An RF pulse return of better than 2.5% is offered, as contrasted to a requirement of 3.0%.

In the cases of Channels 9 and 13, a system specification for VSWR has been set at 1.14. Values better than 1.1 to 1.0 across the band are expected.

Certain relatively minor exceptions to the specifications have been taken. They are explained in the separate appendixes affected and are summarized in the comments on Terms and Conditions in Section VI.

In addition to the offerings of the Basic Bid, several options are provided. This expansion of the response results from RCA's ability to offer antennas for Channels 7, 11 and 31, at nominal increases in cost, which would have electrical operating characteristics which are better than those called for by the requirements.

Descriptions of the antennas suggested and a delineation of the characteristics obtainable are provided in the pertinent Antenna Specification sub-sections. The corresponding prices are given in the Price Summary.

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Appendix 2 WNEW-TV, Ch. 9
Appendix 2 WABC-TV, Ch. 7
WOR-TV, Ch. 9
WPIX-TV, Ch. 11

PROPOSED TELEVISION TOWER CONFIGURATION
WORLD TRADE CENTER
NEW YORK, N. Y.
B-6 MODIFIED

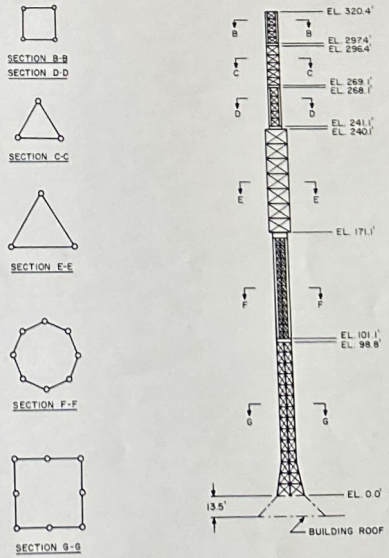

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FIGURE B
SECTION VII

Appendix 1 WCBS-TV, Ch. 2
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Appendix 3 WNEW-TV, Ch. 5
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Appendix 1
WCBS-TV, Ch. 2

Appendix 2
WNBC-TV, Ch. 4

Appendix 3
WNEW-TV, Ch. 5

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Equipment Description

The antenna proposed is a four layer Butterfly type TBF-4 AL designed to radiate an omnidirectional pattern. In the World Trade Center Array, it occupies the position below the polygon antenna for Channel 7 and shares its aperture with the UHF Vee-Zee antenna for Channel 31.

Mechanical

The antenna consists of twelve Butterfly panel radiators affixed to the faces of the triangular supporting tower structure. The panels are arranged in four layers, with three panels per layer. Each panel is comprised of two superturn-stile type radiating elements supported vertically, side by side, in front of a reflecting screen for attachment to the supporting tower members.

A sketch of the mechanical configuration of the antenna follows as Figure 1-2.

The antenna is divided into two sections of two layers each. The six panels in the upper section are fed from a six way junction box using 7/8 inch styroflex feed lines. A 3 1/8 inch coaxial transmission line feeds the junction box. A variable transformer for fine matching is incorporated below the junction box. The six panels of the lower section are fed in a similar fashion from a second junction box which in turn is fed by a 3 1/8 inch coaxial transmission line through a variable transformer. Thus the two sections are independent of each other, making it possible to operate either as a four

bay antenna or as two two-bay antennas. In the latter method, either two-bay may be operated with visual signal, with the other being used for aural, or either pair may be used for diplexed visual and aural.

The two 3 1/8 inch, 50 ohm , transmission lines and the one spare 3 1/8 inch line run down the tower to the transmitter room where they will pass through suitable switching not part of this proposal. The required equipment for division of power for feeding the two lines is understood to be a part of the transmitter room planning and is therefore not provided under this proposal.

Transmission line components required between the antenna and the transmitter room wall have been estimated and are shown in Table 2-2. This list will be corrected to actual requirements after final layout. The price will be correctable at that time at published list values.

Heaters are provided for deicing purposes in the vertical risers of the radiating elements. It is expected that this will maintain normal radiating efficiency under all icing conditions typical of this environment.

Electrical

The calculated vertical patterns for the four and two-bay operation are shown in Figures 2-2 and 3-2.

A measured horizontal pattern, typical of the one anticipated, is shown as Figure 4-2. No practical change in pattern circularity is anticipated between two and four-bay operation.

The mutual coupling of this antenna system to other VHF antennas sharing the support structure will be less than -40dB and to that of UHF antennas less than -45dB. To obtain the isolation from Channel 31 a filter will be supplied. (See comments under Auxiliary Items and Tests and Measurements.)

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 1-2.

General Comments

Despite the fact that the Channel 2 antenna shares its aperture with the Channel 31 antenna, RCA's choice of the TBF-4 AL Butterfly Panel antenna and the Vee Zee panel antenna for Channel 31, will result in excellent pattern circularity. The indicated circularity of better than ± 1.0 dB in the table far exceeds the specified value of ± 1.5 dB. It is based on horizontal pattern measurements of an exact single layer scale model.

AUXILIARY EQUIPMENT

Absorption Filter

Crosstalk energy from the Ch. 31 antenna into the Ch. 2 antenna will be effectively absorbed by a two-hybrid absorption filter. This is composed of two Channel 2 quadrature couplers and two absorbing resistors. Channel 31 energy entering the unit is primarily absorbed by one of the resistors.

A small stub attached at the Channel 2 input port of the unit acts to further isolate the two channels, and directs the remaining Channel 31 leakage energy into the second resistor. The unit is designed to be mounted within Channel 2 transmitter room and will therefore be unpressurized.

A sketch showing the mechanical configuration of the filter is given as Figure 5-2.

The electrical characteristics of the filter are shown in Table 3-2.

Since a requirement for the main antenna is that the upper and lower halves operate independently and be interchangeable, and that they be capable of operating together as a four-bay antenna with combined visual and aural power, two filters have been quoted. These must be incorporated into the transmitter room layout when that planning is done.

Demonstration of meeting the isolation requirement of 40 dB for other VHF antennas and 45 dB for UHF antennas will be provided in the section headed "Tests and Measurements".

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WNBC-TV, Ch. 4
Appendix 3
WNEW-TV, Ch. 5
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WOR-TV, Ch. 9
WPIX-TV, Ch. 11

WCBS-TV

TESTS AND MEASUREMENTS

A. Main Antenna

I. Design Considerations Prior to Shipment

a. Using a single bay model, complete with radiating elements of both Channel 2 and Channel 31, data in the form of horizontal and vertical pattern measurements, with and without the Channel 31 radiators in place, will be taken to substantiate the proposed data of horizontal circularity, beam tilt, null fill, and vertical gain, as set forth in the Specification Summary, Table 1-2. (The two-bay vertical pattern will be determined by calculation from the single bay measured vertical pattern.) Measurements will also be made to provide indicators of mutual coupling and impedance. This data will be submitted to the Engineer for approval before proceeding with the overall system design.

b. Using one bay of the as-built antenna elements in the erect position, and in the final configuration of Channel 2 and Channel 31, horizontal patterns shall be made for Channel 2. This pattern will be demonstrated to meet the circularity set forth in Table 1-2. The measurement will be submitted to the Engineer for approval before the antenna is shipped from the test range.

c. Impedance measurements will be made for each two-bay antenna at 0.5 MHz maximum intervals from 54 MHz to 60 MHz and the results presented on Smith Chart forms to the Engineer for approval, prior to the antenna installation.

d. Prior to actual installation of the transmission line (at the vendors site) an RF pulse measurement (as described in IV below) will be made of each of the three lines (which have been cut and optimized) terminated in a matched load. The magnitude of reflections, caused by transmission line component discontinuities, shall be demonstrated to be less than 1%, measured from the location of the transmitter room wall. Excepted, of course, will be those reflections caused by purposely inserted, narrow band, impedance correcting components.

II. Prior to Erection

Prior to installation on the World Trade Center Building, visual inspection will be made of the antenna components and the transmission lines to make sure that no damage has occurred during shipment.

III. During Erection

D.C. pulse measurements of the transmission line will be made during assembly to insure correct installation. This will be done at frequent intervals as the line is put in, using the standard method of rapping flanges with a rubber mallet at points of junction, to display the character-

istic spasmodic jump of the pulse if a poor joint has been made. A specific value of return amplitude is not meaningful as certain portions of the system such as coaxial transformers and elbows are by nature narrow band and, therefore, produce (correctly) pulse return indications at the 0-50 megahertz frequencies contained in the test pulses. Locations where returns are questionable will be investigated.

IV. After Erection

a. A standard RF pulse measurement will be made on each transmission line, from the patch panel (if in position at the time, otherwise the wall) after installation. The pulse used will be 0.25 micro-second wide, with a repetition rate of 15 KHZ. This pulse will modulate a carrier whose frequency will be 55.25 MHZ. The phase of the RF carrier relative to the reflected sidebands will be adjusted for maximum reflected voltage during the measurement of the reflected pulse. It will be demonstrated that all pulses reflected from transmission line discontinuities unless from purposely inserted impedance modifying components are less than 1% of the incident pulse. Components immediately adjacent to the antenna are of course a part of the antenna as far as the pulse can determine and reflections therefrom become part of the antenna pulse return.

b. With optimization being accomplished by the variable transformers, it will be demonstrated that when using an RF pulse as described above, the reflection from the

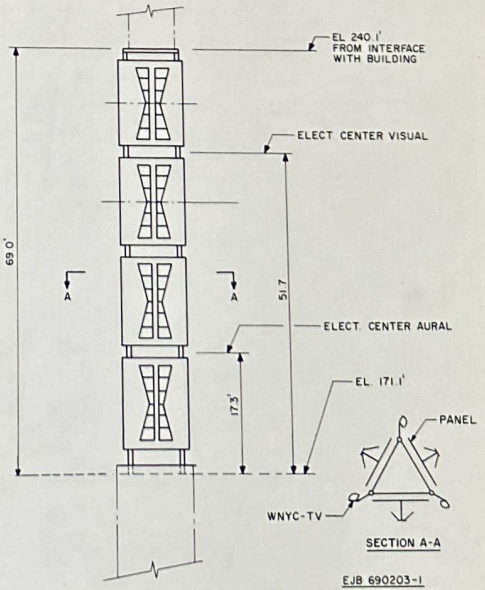
antenna and immediately adjacent transmission line components has been minimized and does not exceed 2.5% of the incident pulse.

c. After performance of "b" above, impedance measurements of each two bay antenna and the related line shall be made at the transmitter room wall to demonstrate that the VSWR values are **within the values set forth in Table 1-2.**

d. Mutual coupling measurements will be made to demonstrate that signals reaching the points of input of the Channel 2 signal into the Channel 2 filters from other VHF antennas sharing the support structure are less than -40 dB below the picture carrier levels of the inputs into those other systems. Further, that signals from UHF systems on the tower are less than -45 dB down from the picture carrier input levels of those systems.

e. Helicopter measurements will be made of the pattern of the main antenna in accordance with the description given elsewhere in this proposal.

WCBS-TV
CHANNEL-2
BUTTERFLY PANEL ANTENNA
MECHANICAL CONFIGURATION



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REVISED 4/14/70

FIGURE 1-2

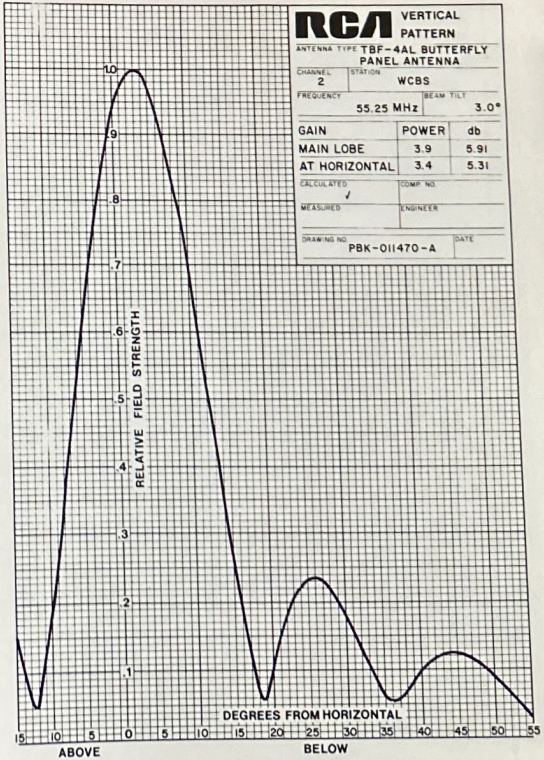

RCA
VERTICAL PATTERN
ANTENNA TYPE TBF-4AL BUTTERFLY PANEL ANTENNA
CHANNEL 2
STATION WCBS
FREQUENCY 55.25 MHz
BEAM TILT 3.0°
GAIN | POWER | db
MAIN LOBE | 3.9 | 5.91
AT HORIZONTAL | 3.4 | 5.31
CALCULATED ✓
COMP. NO.
MEASURED
ENGINEER
DRAWING NO. PBK-011470-A
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
DEGREES FROM HORIZONTAL
15 10 5 0 5 10 15 20 25 30 35 40 45 50 55
ABOVE
BELOW

FIGURE 2-2

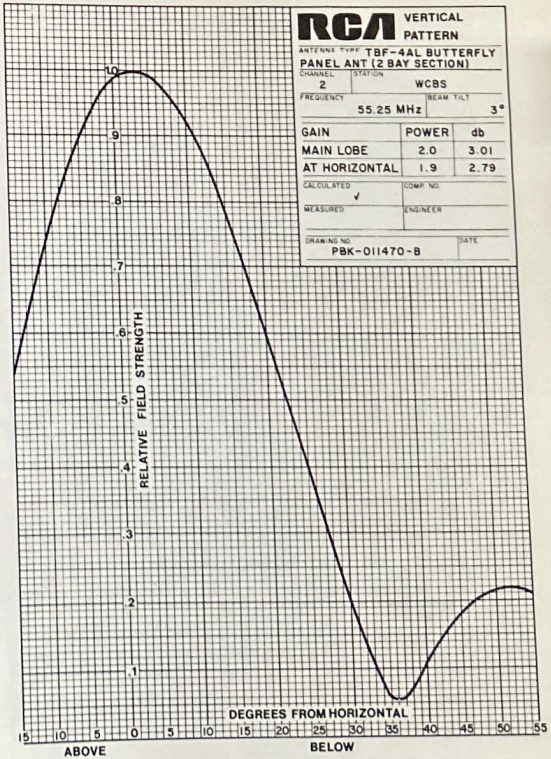
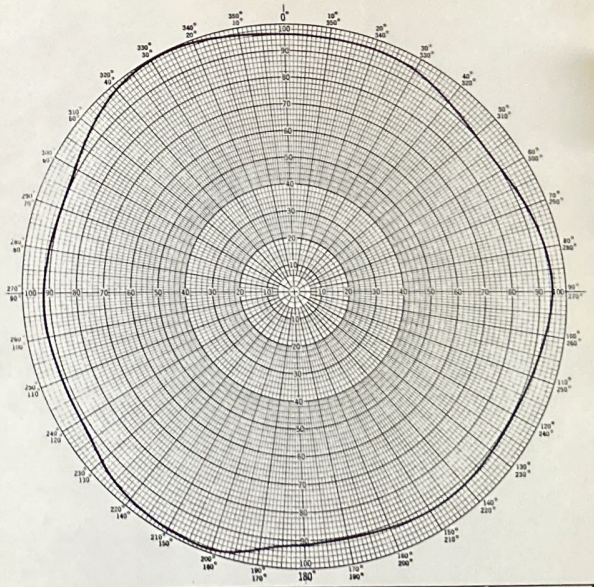

RCA
VERTICAL PATTERN
ANTENNA TYPE TBF-4AL BUTTERFLY PANEL ANT (2 BAY SECTION)
CHANNEL 2
STATION WCBS
FREQUENCY 55.25 MHz
BEAM TILT 3°
GAIN | POWER | db
MAIN LOBE | 2.0 | 3.01
AT HORIZONTAL | 1.9 | 2.79
CALCULATED ✓
COMP. NO.
MEASURED
ENGINEER
DRAWING NO. PBK-011470-B
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
DEGREES FROM HORIZONTAL
15 10 5 0 5 10 15 20 25 30 35 40 45 50 55
ABOVE
BELOW

FIGURE 3-2



REMARKS	RCA
REFER GEE-022070-1	HORIZONTAL PATTERN
NOTE: CHANNEL 2 MODEL MEASUREMENT	ANT. TYPE TBF-4AL BUTTERFLY PANEL ANT.
WITH CHANNEL 31 VEE-ZEE ANTENNA	CHANNEL 2 STATION WCBS-TV
SHARING THE SAME APERTURE	LOCATION "WTC", N.Y.C.
	FREQUENCY 55.25 MHz GAIN —
	DATE
	Calculated Comp. No.
	Measured ✓ Eng.
FIGURE 4-2	DRAWING NO. PBK-042170-A

WCBS-TV
MECHANICAL CONFIGURATION
CHANNEL 31 ABSORPTION FILTER

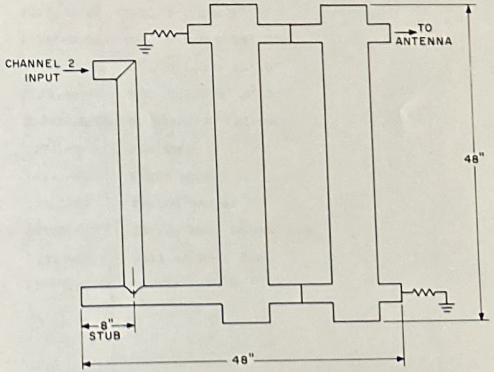


FIGURE 5-2

RCA No. _____ **SCHEDULE A** PAGE _____ OF _____

Table 2-2

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WCBS-TV - Channel 2		
				Transmission Line Requirements		
				Main Antenna (Two 3-1/8" Lines)		
		26	27791-D-1A	T/L, 3 1/8 x 20' 0"		
		2	27791-D-99	T/L, 3 1/8 x 17' 0"		
		2	27791-D-99	T/L, 3 1/8 x 14' 6"		
		2	27791-D-99	T/L, 3 1/8 x 12' 0"		
		2	27791-D-99	T/L, 3 1/8 x 3' 0"		
		10	27791-2A/2B	Coupling 90° elbow		
		2	27791-D-3	Gas stop		
		12	19313-44	Fixed hanger		
		34	19313-32	Expand hanger		
		2	27700	Inside hor. hanger kit		
		1	19313-18	Wall anchor, dual		
		2	27791-D-4B	Adaptor, male		

ABSORPTION FILTER

CHANNEL 31/2

ELECTRICAL CHARACTERISTICS

VSWR (channel 2 input)*	1.035 maximum (with matched terminations)
Isolation from channel 31* (due to filter)	– 10 dB (at channel 2 input port)
Anticipated total isolation	45 dB (Including antenna isolation)

*To be measured during development at the manufacturing site.

TABLE 3-2

RCA No. _____

SCHEDULE A

PAGE _____ OF _____

Table 4-2

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WCBS-TV - Channel 2		
				Transmission Line Requirements		
				<u>Spare Run</u> (One 3 1/8" Line)		
		13	27791-D-1A	T/L, 3 1/8 x 20' 0"		
		1	27791-D-99	T/L, 3 1/8 x 17' 0"		
		1	27791-D-99	T/L, 3 1/8 x 14' 6"		
		1	27791-D-99	T/L, 3 1/8 x 12' 0"		
		1	27791-D-99	T/L, 3 1/8 x 3' 0"		
		5	27791-2A/2B	Coupling 90° elbows		
		1	27791-D-3A	Gas stop		
		6	19313-44	Fixed hanger		
		17	19312-32	Expand hanger		
		1	27700	Inside hor. hanger kit		
		1	19313-17	Wall anchor, single		
		1	27791-D-8B	End cap, male		
		3	27791-D-4B	Adaptor		

Appendix 3
WNBC-TV, Ch. 4

Appendix 3
WNEW-TV, Ch. 5

Appendix 3
WABC-TV, Ch. 7

Appendix 3
WOR-TV, Ch. 9

Appendix 3
WPIX-TV, Ch. 11

SECTION VII APPENDIX 2

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WNBC - TV

Channel 4

Equipment Description

The main antenna proposed is a two layer superturnstile type TF-2BM(S) diplexed for Channels 4 and 5. It is designed to operate with a power gain of 1.9 and an omnidirectional pattern. In the World Trade Center Array, the antenna will occupy the top-most position, above that of Channel 11.

Mechanical

Each layer of the antenna consists of four radiating elements mounted at 90° to each other around a pole. One plane of these radiators, is known, for descriptive purposes, as the N-S system and the other, the E-W system. When the N-S and the E-W systems are placed at 90° space and phase relationship they produce an omnidirectional pattern.

Heaters in each radiator element provide deicing facilities.

A sketch of the mechanical configuration of the antenna follows as figure 1-4/5.

The radiating elements are fed by 1-5/8 inch feed lines, capable of handling power sufficient to allow operation of both Channel 4 and Channel 5 at full licensed ERP from either antenna layer for an indefinite period in any season. The two feed lines from the top layer of the N-S system are fed from a powerdividing tee mounted on the pole. The same applies to the top layer of the E-W system. Each of the two powerdividing tees is fed by a 3-1/8", 50 ohm coaxial transmission line. These two transmission lines are connected to the outputs of a coaxial coupler located inside the shell of the antenna below. A similar arrangement is used for the bottom layer also. Four variable transformers are located at the inputs to the coaxial couplers. The result of this arrangement is that there is one input port in the coupler for the upper bay and one in the lower bay for each channel.

The two 3-1/8 inch transmission lines for Channel 4 run down the tower to the transmitter room where they will pass through suitable switching, (not a part of this proposal). Completely independent operation of either layer or of the two together can be arranged at that point. A 70/30 power dividing tee, suitable for feeding the two lines and providing null fill

in the pattern and the two absorption filters, are included in the proposal and should be incorporated into transmitter room planning. They are assumed to be available for both main and standby operation by suitable switching.

A sketch of the transmission line arrangement is included herein as Figure 2-4/5.

Transmission line components required between the antenna and the transmitter room wall have been estimated and are shown in table 3-4. This list will be corrected to actual requirements after final layout. The price will be corrected at that time at published list values.

Electrical

The calculated vertical patterns for the two bay and single bay operation are shown in figures 3-4 and 4-4.

A calculated horizontal pattern is shown in figure 5-4.

Specifications

A summary of the mechanical and electrical specifications proposed are shown in Table 1-4.

Auxiliary Equipment

A. Absorption Filters

To provide isolation from the signal transmitted by Channel 5, two absorption filters, one in each transmission line, are to be provided. Inserted at the locations shown in figure 2-4/5, they will function in both the main and standby conditions to pass the Channel 4 signal and absorb unwanted signal from Channel 5 by an amount of not less than 50 dB below the Channel 4 sync tip power level.

The degree of isolation obtained will be measured as outlined under "Tests and Measurements."

The absorption filter proposed has a design similar to that of a notch diplexer. The signal to be transmitted passes through an input port of a hybrid, divides in two branches of the hybrid and exits to the antenna line through an output port of a hybrid. The unwanted signal, coming down the output line, enters the output port of the hybrid, divides in the ratrace, is reflected from cavities, and passes into a load on the second port of the output hybrid. See Figure 11-4 for general configuration of this filter.

The isolation so obtained is additive to that obtained in the coaxial coupler, located in the antenna.

Two absorption filters are required for the operation of the diplexed antenna by Channel 4, one in the line from the upper bay and one in the line from the lower bay. Since they are to be installed in the transmitter room, they are to be ungassed. Their specific location should be determined at the time of the transmitter room layout.

The electrical characteristics of the filter are shown in Table 4-4.

The price of those filters is given under Auxiliary Items in the price summary.

B. Dehydrator and Bleeding Facilities

A 1 std. cu. ft. per minute dehydrator type RCA MI-563170-1 with necessary transmission line fittings will be provided to maintain positive pressure and dry air in the main and standby lines. Bleeder facilities will be provided close to the antenna and in a protected area.

C. Voltage Sampling

Two coaxial RF sampling cables, (RG-8 or equivalent) will be supplied to both the main and standby antennas. These

cables will be long enough for termination in the transmitter room and will end in capped type-N chassis type fittings protected in a weatherproof box at the antenna terminals.

WNBC-TV

Channel 4

Standby Antenna

The antenna proposed is a two layer butterfly panel type, designed to provide omnidirectional service using either a single layer with a power gain of 0.9 or both layers with a power gain of 1.9. It is mounted immediately above the FM antenna in the World Trade Center Array.

The system is diplexed for joint operation with Channel 5. It may also be used as an alternate FM facility.

Mechanical

The antenna consists of eight butterfly panel radiators mounted on the faces of the square section supporting tower. The panels are arranged in two layers, with four panels in each layer. Each panel is comprised of two batwing radiators, of the type used in the superturnstile antenna, mounted vertically side by side in front of a screen.

A sketch of the mechanical configuration of the antenna follows in Figure 6-4/5.

The feed system is identical for both layers. Each layer has two 3-1/8 inch coaxial line inputs to a coaxial coupler, one

for each channel. The output of the coupler is two 3-1/8 inch lines, each of which feeds a two-way power divider which in turn feeds two panels through 1-5/8 inch styroflex lines. A variable transformer is provided close to the input to the coaxial coupler for fine matching of the antenna.

An estimate of transmission line components required between the antenna and the transmitter room is shown in Table 5-4. This list will be corrected upon final layout and the price adjusted at published list.

When switching is carried out between the main and standby systems, the Tee and absorption filters have to be transferred also, hence only one set has been provided in this proposal.

Either layer of this antenna may be used as an alternate FM facility. The VSWR of each layer and transmission line system at the FM carrier frequency of WNBC as measured at the wall of the transmitter room will be 1.3 or better under conditions of 4.1 kw input power. This will be accomplished by insertion of an adaptor supplied as part of this proposal at an appropriate point in the FM transmission line layout of the transmitter room.

It is recommended that decision on the use of an isolation filter in the circuit when the standby antenna is used for FM be deferred until after tests and experience after installation indicate the degree and frequency of isolation needed, if any. Such a filter can then be purchased for a nominal additional cost.

Heaters are provided in the vertical risers of the radiating elements for deicing purposes.

Electrical

The calculated vertical pattern for two bay operation is shown in Figure 8-4, and for a single bay in Figure 9-4. (Note that the two bay pattern has a slightly smaller fill than .15 in the first null due to the 70-30 requirement in power division.) The anticipated horizontal pattern which is the same for either mode of operation is shown in Figure 10-4.

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 2-4.

WNBC-TV

Tests and Measurements

A. Main Antenna

I. Design Considerations Prior to Shipment

The antenna is a custom two layer superturnstile for providing diplexed operation. The antenna and the feed system will be assembled at the RCA Antenna Engineering Center, Gibbsboro, N.J. Inpedance measurements will be made and developed for diplexed operation for each of the two layers, with the antenna mounted in a vertical position. Variable transformers are provided at the input to the coaxial couplers to optimize the match if necessary. Additional variable transformers will be provided with the transmission lines that run up the mast to optimize the match if necessary.

The TF-2BM line of antennas was developed as early as 1953, and has been a catalog, off-the-shelf item since then. The electrical pattern characteristics are, therefore, so thoroughly known that the omission of pattern tests at the RCA test site is recommended without reservation. The antenna will be shipped assembled, to World Trade Center Building.

II. Prior to Erection

Prior to installation on the World Trade Center Building, visual inspection will be made of the antenna and the transmission lines to make sure that no damage has occurred during shipment.

III. During Erection

D.C. pulse measurements of the transmission line will be made during assembly to insure correct installation. This will be done at frequent intervals as the line is put in, using the standard method of rapping flanges with a rubber mallet at points of junction, to display the characteristic spasmodic jump of the pulse if a poor joint has been made. A specific value of return amplitude is not meaningful as certain portions of the system such as coaxial transformers and elbows are by nature narrow band and, therefore, produce (correctly) pulse return indications at the 0-50 megahertz frequencies contained in the test pulses. Locations where returns are questionable will be investigated.

IV. After Erection

A. A standard RF pulse measurement will be made from the transmitter room wall after complete installation of transmission lines and antennas up to this point has

been accomplished. Optimization will be accomplished by adjustment of the variable transformer. The measurement will demonstrate that the returning pulse from the antenna does not exceed 2.5% of the test pulse.

B. VSWR measurements will be made at the wall of the transmitter room looking into each transmission line terminated in its relatedportion of the antenna to demonstrate that values do not exceed 1.13 across the channel.

C. The complete system will be pressurized to 10 lbs. and suitable measurements made to demonstrate that it is gas tight.

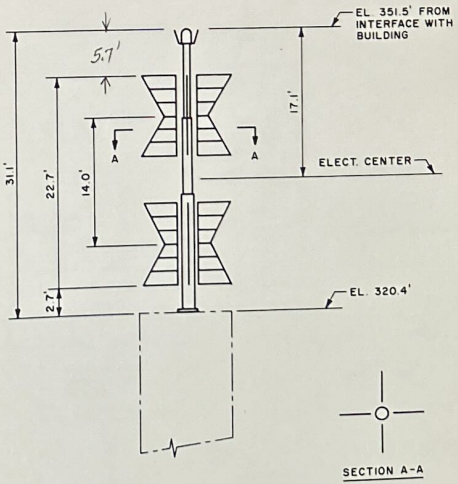
D. Decoupling measurements will be made to demonstrate that the 50 dB requirement has been met.

B. <u>Standby Antenna</u>

The same measurements to demonstrate performance as in II, III and IV above will be made for the standby antenna as for the main antenna above, except that the RF pulse response shall be optimized by standard sweep technique if the transmission line is judged to be too short for RF pulse measurements.

A measurement from the transmitter room wall will be made into each layer of the standby antenna at the related FM carrier frequency to demonstrate that the required 1.3 VSWR response has been obtained.

WNBC-TV/WNEW-TV
CHANNELS 4/5
DIPLEXED SUPERTURNSTILE ANTENNA
MECHANICAL CONFIGURATION



EJB 690201-1
REVISED 4/14/70

FIGURE 1-4/5

WNBC-TV/WNEW-TV
CHANNELS 4/5
DIPLEXED SUPERTURNSTILE ANTENNA
FEEDSYSTEM ARRANGEMENT

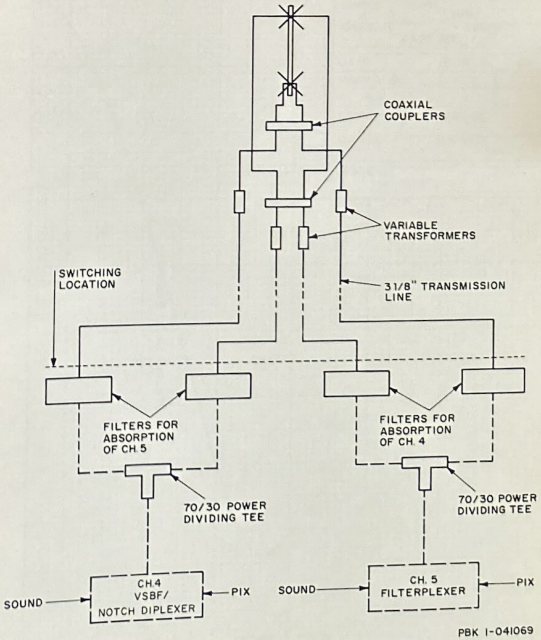


FIGURE 2-4/5

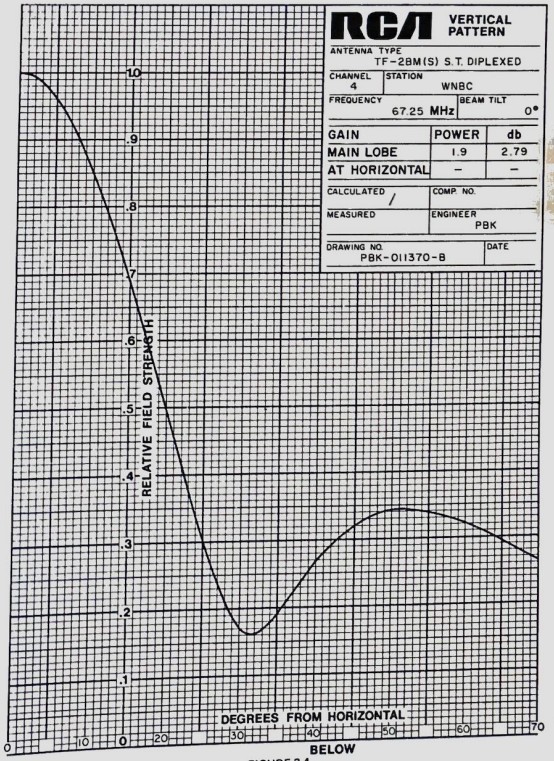

RCA
VERTICAL PATTERN
ANTENNA TYPE
TF-28M(S) S.T. DIPLEXED
CHANNEL 4
STATION WNBC
FREQUENCY 67.25 MHz
BEAM TILT 0°
GAIN | POWER | db
MAIN LOBE | 1.9 | 2.79
AT HORIZONTAL | – | –
CALCULATED
COMP. NO.
MEASURED
ENGINEER PBK
DRAWING NO. PBK-011370-B
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
10
20
30
40
50
60
70
DEGREES FROM HORIZONTAL
BELOW

FIGURE 3-4

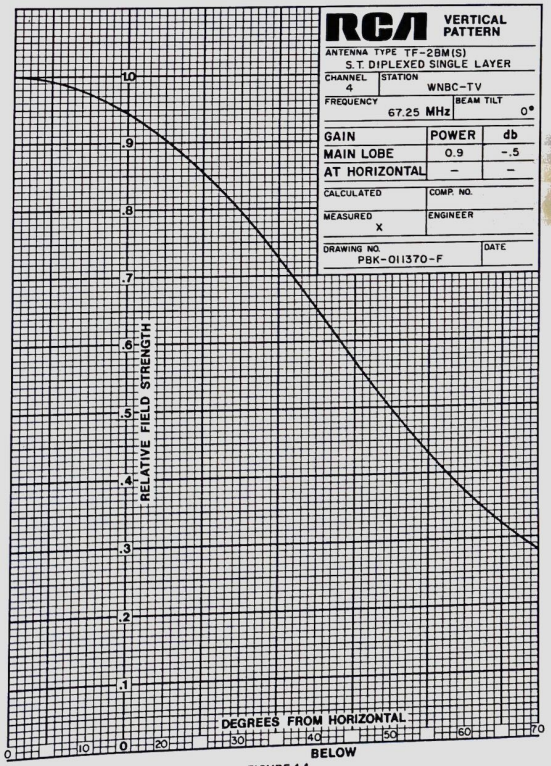
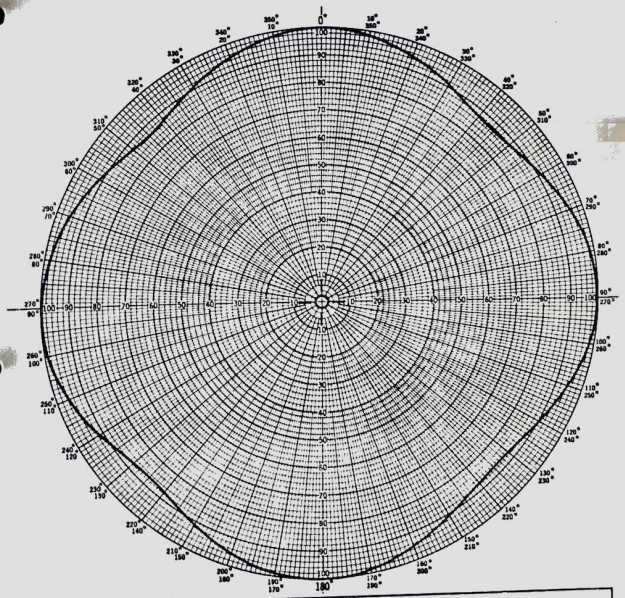

RCA
VERTICAL PATTERN
ANTENNA TYPE TF-2BM(S)
S.T. DIPLEXED SINGLE LAYER
CHANNEL 4
STATION WNBC-TV
FREQUENCY 67.25 MHz
BEAM TILT 0°
GAIN | POWER | db
MAIN LOBE | 0.9 | -.5
AT HORIZONTAL | – | –
CALCULATED
COMP. NO.
MEASURED X
ENGINEER
DRAWING NO. PBK-011370-F
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
DEGREES FROM HORIZONTAL
10
20
30
40
50
60
70
BELOW

FIGURE 4-4



REMARKS

ANTICIPATED PATTERN

FIGURE 5-4

RCA

HORIZONTAL PATTERN

ANT. TYPE TF-28M (S) S.T. DIPLEXED

CHANNEL 4 STATION WNBC-TV

LOCATION "WTC", N.Y.C.

FREQUENCY 67.25 MHz GAIN —

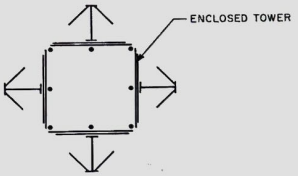
DATE FEBRUARY 3, 1969

Calculated — Comp. No. —

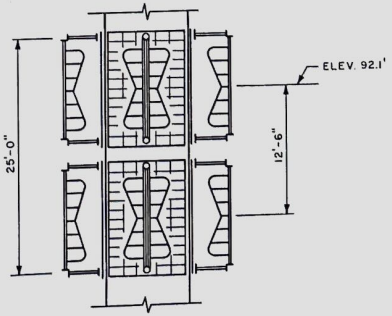
Measured — Eng. D.A.B.

DRAWING NO. DAB-020369-A

WNBC-TV/WNEW-TV
CHANNELS 4/5
EMERGENCY ANTENNA



PLAN



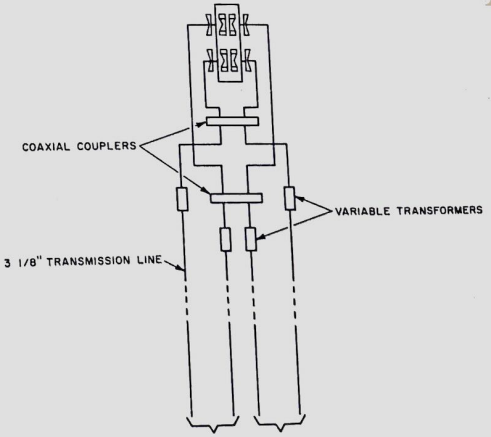
ELEVATION

EJB 700423-1

FIGURE 6-4/5

WNBC-TV/WNEW-TV
CHANNELS 4/5

DIPLEXED SUPERTURNSTILE
STANDBY ANTENNA
FEEDSYSTEM ARRANGEMENT



PBK-042470

FIGURE 7-4/5

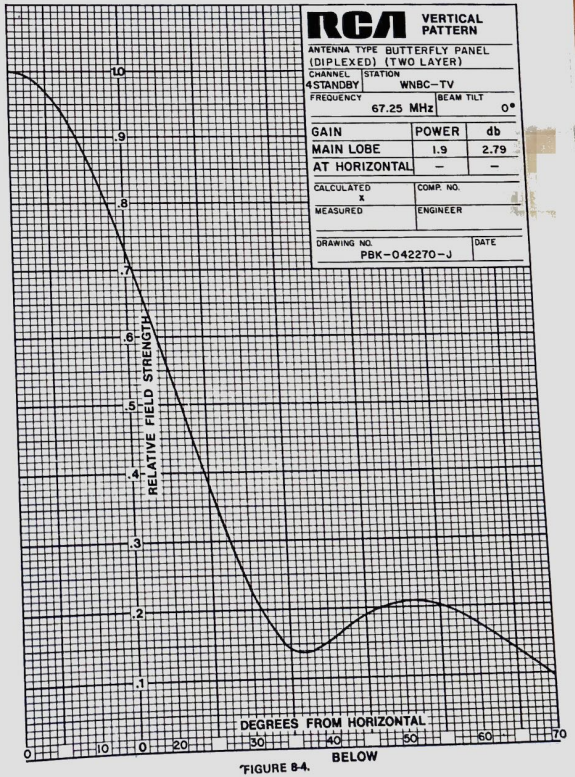

RCA
VERTICAL PATTERN
ANTENNA TYPE BUTTERFLY PANEL (DIPLEXED) (TWO LAYER)
CHANNEL 4 STANDBY
STATION WNBC-TV
FREQUENCY 67.25 MHz
BEAM TILT 0°
GAIN | POWER | db
MAIN LOBE | 1.9 | 2.79
AT HORIZONTAL | — | —
CALCULATED x
COMP. NO.
MEASURED
ENGINEER
DRAWING NO. PBK-042270-J
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
10
20
30
40
50
60
70
DEGREES FROM HORIZONTAL
BELOW

FIGURE 8-4.

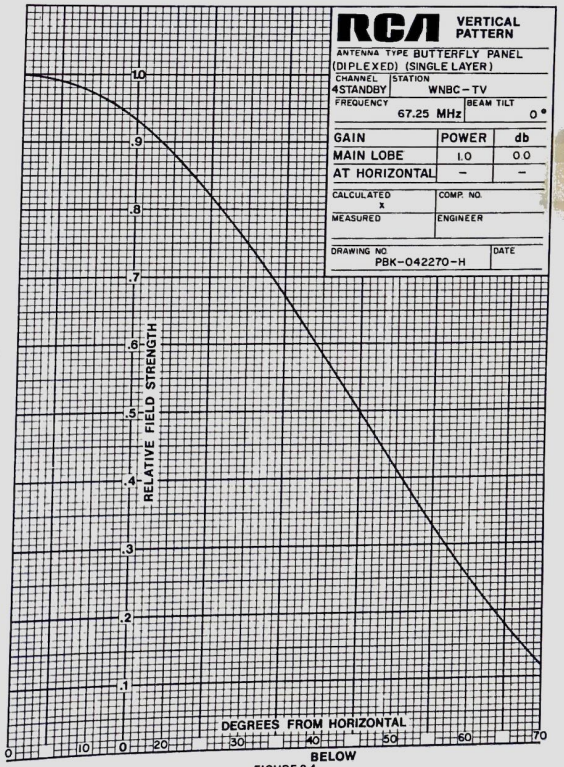
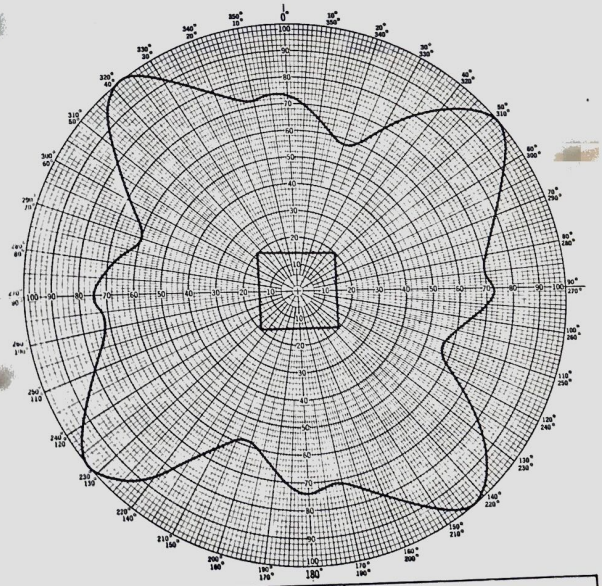

RCA
VERTICAL PATTERN
ANTENNA TYPE BUTTERFLY PANEL (DIPLEXED) (SINGLE LAYER)
CHANNEL 4STANDBY
STATION WNBC-TV
FREQUENCY 67.25 MHz
BEAM TILT 0°
GAIN | POWER | db
MAIN LOBE | 1.0 | 0.0
AT HORIZONTAL | – | –
CALCULATED X
MEASURED
COMP. NO.
ENGINEER
DRAWING NO. PBK-042270-H
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
10
0
20
30
40
50
60
70
DEGREES FROM HORIZONTAL
BELOW

FIGURE 9-4



REMARKS	RCA
ANTICIPATED PATTERN REFER 1/15/68 OBD	HORIZONTAL PATTERN
	ANT. TYPE BUTTERFLY PANEL (DIPLEXED)
	CHANNEL 4 STANDBY STATION WNBC-TV
	LOCATION "WTC", N.Y.C.
	FREQUENCY 67.25 MHz GAIN —
	DATE
	Calculated Comp. No.
	Measured ✓ Eng. OBD
FIGURE 10-4	DRAWING NO. PBK-042170-J

WNEW-TV, CH. 5 WABC-TV, CH. 7 WOR-TV, CH. 9 WPIX-TV, CH. 11

ABSORPTION FILTER
WNBC-TV
CHANNEL 4
MECHANICAL CONFIGURATION

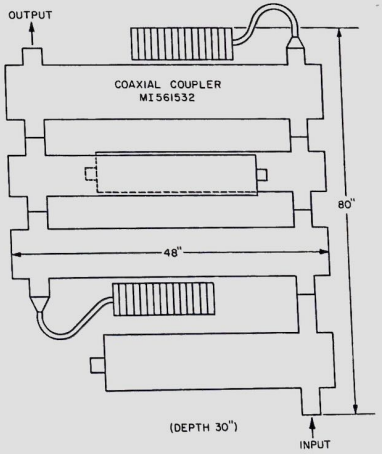


FIGURE 11-4

RCA No. _____

SCHEDULE A

PAGE _____ OF _____

Table 3-4

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WNBC-TV - Channel 4		
				Transmission Line Requirements		
				Main Antenna (Two 3-1/8" Lines)		
		58	27791-D-1A	T/L, 3 1/8 x 20' 0"		
		2	27791-D-99	T/L, 3 1/8 x 18' 0"		
		2	27791-D-99	T/L, 3 1/8 x 17' 0"		
		2	27791-D-99	T/L, 3 1/8 x 15' 6"		
		4	27791-D-99	T/L, 3 1/8 x 12' 0"		
		2	27791-D-99	T/L, 3 1/8 x 3' 0"		
		30	27791-D-2A/2B	Coupling 90° elbow		
		2	27791-D	Gas stop		
		10	19313-44	Fixed hanger		
		66	19313-32	Expand hanger		
		4	27700	Inside hor. hanger kit		
		2	19313-17	Wall anchor single		
		2	27791-D4B	Field Flange, male		

EDP 944

ABSORPTION FILTER

CHANNEL 5

ELECTRICAL CHARACTERISTICS

VSWR (Channel 4 input)*	1.05 maximum (with matched terminations)
Passband Efficiency*	95% Minimum
Anticipated Total Isolation (From opposite channel)	50 dB (Including combining coupler isolation)
Input Power Capability	25 KW (each channel)
Rereflected Energy (of opposite channel)*	Less than 1% (Including combining coupler isolation)

*To be measured during development at manufacturers site.

TABLE 4-4

RCA No. _____ **SCHEDULE A** PAGE _____ OF _____

Table 5-4

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WNBC-TV - Channel 4		
				Transmission Line Requirements		
				<u>Standby Antenna</u>		
		26	27791-D-1A	T/L, 3 1/8 x 20' 0"		
		2	27791-D-99	T/L, 3 1/8 x 18' 0"		
		2	27791-D-99	T/L, 3 1/8 x 17' 0"		
		2	27791-D-99	T/L, 3 1/8 x 15' 6"		
		2	27791-D-99	T/L, 3 1/8 x 12' 0"		
		10	27791-D-2A/2B	Coupling, 90° elbow		
		2	27791-D	Gas stop		
		10	19313-44	Fixed hanger		
		14	19313-32	Expand hanger		
		4	27700	Inside horiz. hanger kit		
		2	19313-17	Wall anchor		
		2	27791-D-4B	Adaptor, male		

EDP 944

SECTION VII APPENDIX 3

Equipment Description	Page	1-3
Auxiliary Equipment		4-6
Standby Antenna		7-9
Tests and Measurements		10-12
Antenna Sketch	Figure	1-4/5
Transmission Line Layout		2-4/5
Vertical Pattern (2 layers)		3-5
Vertical Pattern (1 layer)		4-5
Horizontal Pattern		5-5
Antenna Sketch (Standby)		6-4/5
Transmission Line Layout for Standby Antenna		7-4/5
Vertical Pattern (Standby) (2 bay)		8-5
Vertical Pattern (Standby) (1 bay)		9-5
Horizontal Pattern (Standby)		10-5
Absorption Filter Sketch		11-5
Specification Summary	Table	1-5
Specification Summary (Standby)		2-5
Transmission Line Equipment List (Main)		3-5
Absorption Filter Specification		4-5
Transmission Line Equipment List (Standby)		5-5

WNEW-TV

Channel 5

Equipment Description

The main antenna proposed is a two layer superturnstile type TF-2BM(S) diplexed for Channels 4 and 5. It is designed to operate with a power gain of 2.0 and an omnidirectional pattern. In the World Trade Center Array, the antenna will occupy the top-most position, above that of Channel 11.

Mechanical

Each layer of the antenna consists of four radiating elements mounted at 90° to each other around a pole. One plane of these radiators, is known, for descriptive purposes, as the N-S system and the other, the E-W system. When the N-S and the E-W systems are placed at 90° space and phase relationship they produce an omnidirectional pattern.

Heaters in each radiator element provide deicing facilities.

A sketch of the mechanical configuration of the antenna follows as Figure 1-4/5.

The radiating elements are fed by 1-5/8 inch feed lines, capable of handling power sufficient to allow operation of both Channel 4 and Channel 5 at full licensed ERP from either antenna layer

for an indefinite period in any season. The two feed lines from the top layer of the N-S system are fed from a powerdividing tee mounted on the pole. The same applies to the top layer of the EW system. Each of the two power dividing tees are fed by a 3-1/8 50 ohm coaxial transmission line. These two transmission lines are connected to the outputs of a coaxial coupler located inside the shell of the antenna below. A similar arrangement is used for the bottom layer also. Four variable transformers are located at the inputs to the coaxial couplers. The result of this arrangement is that there is one input port in the coupler for the upper bay and one in the lower bay for each channel.

The two 3-1/8 inch transmission lines for Channel 5 run down the tower to the transmitter room where they will pass through suitable switching (not a part of this proposal). Completely independent operation of either layer or of the two together can be arranged at that point. A 70/30 power dividing tee, suitable for feeding the two lines and providing null fill in the pattern and the two absorption filters are included in the proposal and should be incorporated into transmitter room planning. They are assumed to be available for both main and standby operation by suitable switching.

A sketch of the transmission line arrangement is included herein as Figure 2-4/5.

Transmission line components required between the antenna and the transmitter room wall have been estimated and are shown in Table 3-5. This list will be corrected to actual requirements after final layout. The price will be corrected at that time at published list values.

Electrical

The calculated vertical patterns for the two bay and single bay operation are shown in Figures 3-5 and 4-5.

A calculated horizontal pattern is shown in Figure 5-5.

Specifications

A summary of the mechanical and electrical specifications proposed as shown in Table 1-5.

Auxiliary Equipment

A. Absorption Filters

To provide isolation from the signal transmitted by Channel 4, two absorption filters, one in each transmission line, are to be provided. Inserted at the locations shown in Figure 2-4/5, they will function in both the main and standby conditions to pass the Channel 5 signal and absorb unwanted signal from Channel 4 by an amount of not less than 50dB below the Channel 5 synch. tip power level.

The degree of isolation obtained will be measured as outlined under "Tests and Measurements".

The absorption filter proposed has a design similar to that of a notch diplexer. The signal to be transmitted passes through an input port of a hybrid, divides in two branches of a hyrbid and exits to the antenna line through an output port of a hybrid. The unwanted signal, coming down the output line, enters the output port of the hybrid, divides in the ratrace, is reflected from cabities, and passes into a load on the second port of the output bybrid. See Figure 11-5 for general configuration of this filter.

The isolation so obtained is additive to that obtained in the coaxial coupler located in the antenna.

Two absorption filters are required for the operation of the diplexed antenna by Channel 5, one in the line from the upper bay and one in the line from the lower bay, since they are to be installed in the transmitter room. They are to be ungassed. Their specific location should be determined at the time of the transmitter room layout.

The electrical characteristics of the filter are shown in Table 4-5.

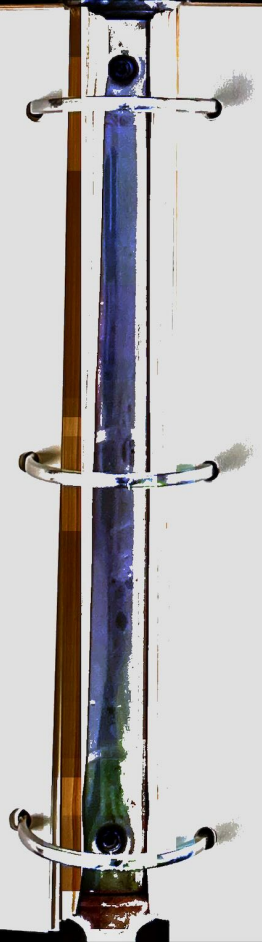
The price of those filters is given under Auxiliary Items in the price summary.

B. Dehydrator and Bleeding Facilities

A 1 std. cu. ft. per minute dehydrator type RCA MI-563170-1, with necessary transmission line fittings, will be provided to maintain positive pressure and dry air in the main and standby lines. Bleeder facilities will be provided close to the antenna and in a protected area.

C. Voltage Sampling

Two coaxial RF sampling cables, (RG-8 or equivalent) will be supplied to both the main and standby antennas. These



cables will be long enough for termination in the transmitter room and will end in capped type-N chassis type fittings protected in a weatherproof box at the antenna terminals.

WNEW-TV

Channel 5

Standby Antenna

The antenna proposed is a two layer butterfly panel type, designed to provide omnidirectional service using either a single layer with a power gain of 0.9 or both layers with a power gain of 1.9. It is mounted immediately above the FM antenna in the World Trade Center Array.

The system is diplexed for joint operation with Channel 4. It may also be used as an alternate FM facility.

Mechanical

The antenna consists of eight butterfly panel radiators mounted on the faces of the square section supporting tower. The panels are arranged in two layers, with four panels in each layer. Each panel is comprised of two batwing radiators, of the type used in the superturnstile antenna, mounted vertically side by side in front of a screen.

A sketch of the mechanical configuration of the antenna follows in figure 6-4/5.

The feed system is identical for both layers. Each layer has two 3-1/8 inch coaxial line inputs to a coaxial coupler - one for each channel. The output of the coupler is two 3-1/8 inch

lines, each of which feeds a two-way power divider which in turn feeds two panels through 1-5/8 inch styroflex lines. A variable transformer is provided close to the input to the coaxial coupler for fine matching of the antenna.

An estimate of transmission line components required between the antenna and the transmitter room is shown in Table 5-5. This list will be corrected upon final layout and the price adjusted at published list value.

When switching is carried out between the main and standby systems, the tee and absorption filters have to be transferred also, hence only one set of tees and absorption filters has been provided in this proposal.

Either layer of this antenna may be used as an alternate FM facility. The VSWR of each layer and transmission line system at the FM carrier frequency of WNEW as measured at the wall of the transmitter room will be 1.3 or better under conditions of 4.1 kw input power. This will be accomplished by insertion of an adaptor supplied as part of this proposal at an appropriate point in the FM transmission line layout of the transmitter room.

It is recommended that decision on the use of an isolation filter in the circuit when the standby antenna is used for FM be deferred until after tests and experience after installation indicate the degree and frequency of isolation needed, if any. Such a filter can then be purchased for a nominal additional cost.

Heaters are provided in the vertical risers of the radiating elements for deicing purposes.

Electrical

The calculated vertical pattern for two bay operation is shown in Figure 8-5 and for a single bay in Figure 9-5. The anticipated horizontal pattern which is the same for either mode of operation is shown in Figure 10-5.

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 2-5.

WNEW-TV

Tests and Measurements

A. Main Antenna

I. Design Considerations Prior to Shipment

The antenna is a custom two layer superturnstile for providing diplexed operation. The antenna and the feed system will be assembled at the RCA Antenna Engineering Center, Gibbsboro, N.J.. Impedance measurements will be made and developed for diplexed operation for each of the two layers, with the antenna mounted in a vertical position. Variable transformers are provided at the input to the coaxial couplers to optimize the match if necessary. Additional variable transformers will be provided with the transmission lines that run up the mast to optimize the match if necessary.

The TF-2BM line of antennas was developed as early as 1953, and has been a catalog, off-the-shelf item since then. The electrical pattern characteristics are, therefore, so thoroughly known that the omission of pattern tests at the RCA test site is recommended without reservation. The antenna will be shipped assembled, to World Trade Center Building.

II. Prior to Erection

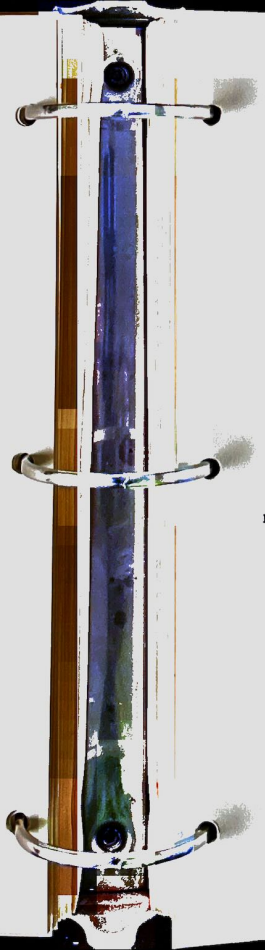
Prior to installation on the World Trade Center Building, visual inspection will be made of the antenna and the transmission lines to make sure that no damage has occurred during shipment.

III. During Erection

D.C. pulse measurements of the transmission line will be made during assembly to insure correct installation. This will be done at frequent intervals as the line is put in, using the standard method of rapping flanges with a rubber mallet at points of junction, to display the characteristic spasmodic jump of the pulse if a poor joint has been made. A specific value of return amplitude is not meaningful as certain portions of the system such as coaxial transformers and elbows are by nature narrow band and, therefore, produce (correctly) pulse return indications at the 0-50 megahertz frequencies contained in the test pulses. Locations where returns are questionable will be investigated.

IV. After Erection

a) A standard RF pulse measurement will be made from the transmitter room wall after complete installation of transmission lines and antennas up to this point has been accomplished. Optimization will be accomplished by adjustment of the variable transformer. The measure-



ment will demonstrate that the returning pulse from the antenna does not exceed 2.5% of the test pulse.

b) VSWR measurements will be made at the wall of the transmitter room looking into each transmission line terminated in its related portion of the antenna to demonstrate that values do not exceed 1.13 across the channel.

c) The complete system will be pressurized to 10 lbs. and suitable measurements made to demonstrate that it is gas tight.

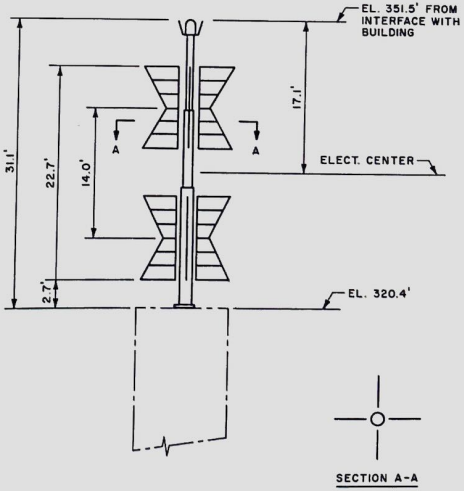
d) Decoupling measurements will be made to demonstrate that the 50 dB requirement has been met.

B. Standby Antenna

The same measurements to demonstrate performance as in II, III and IV above will be made for the standby antenna as for the main antenna above, except that the RF pulse response shall be optimized by standard sweep technique if the transmission line is judged to be too short for RF pulse measurements.

A measurement from the transmitter room wall will be made into each layer of the standby antenna, at the relative FM carrier frequency to demonstrate that the required 1.3 VSWR response has been obtained.

WNBC-TV/WNEW-TV
CHANNELS 4/5
DIPLEXED SUPERTURNSTILE ANTENNA
MECHANICAL CONFIGURATION



EJB 690201-1
REVISED 4/14/70

FIGURE 1-4/5

WNBC-TV/WNEW-TV
CHANNELS 4/5
DIPLEXED SUPERTURNSTILE ANTENNA
FEEDSYSTEM ARRANGEMENT

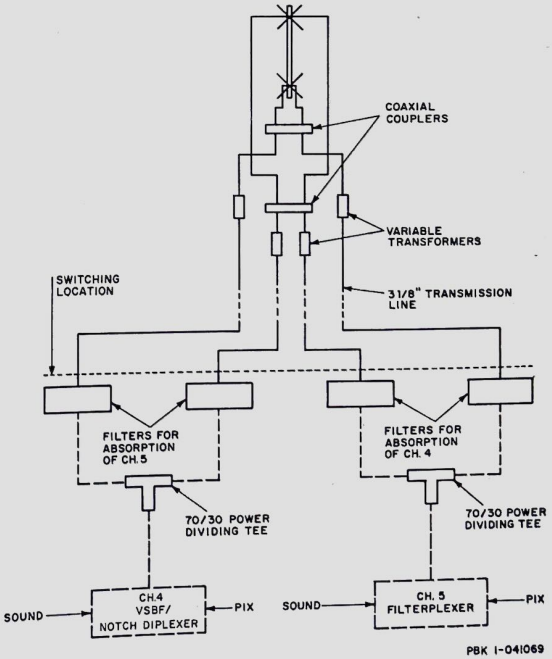


FIGURE 2-4/5

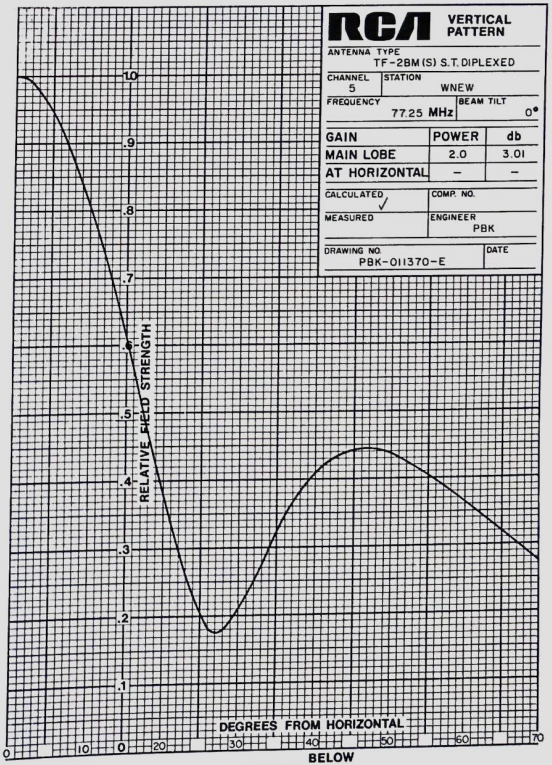

RCA
VERTICAL PATTERN
ANTENNA TYPE
TF-2BM(S) S.T. DIPLEXED
CHANNEL
5
STATION
WNEW
FREQUENCY
77.25 MHz
BEAM TILT
0°
GAIN
POWER
db
MAIN LOBE
2.0
3.01
AT HORIZONTAL
–
–
CALCULATED ✓
COMP. NO.
MEASURED
ENGINEER
PBK
DRAWING NO.
PBK-011370-E
DATE
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
RELATIVE FIELD STRENGTH
0
10
0
20
30
40
50
60
70
DEGREES FROM HORIZONTAL
BELOW

FIGURE 3-5

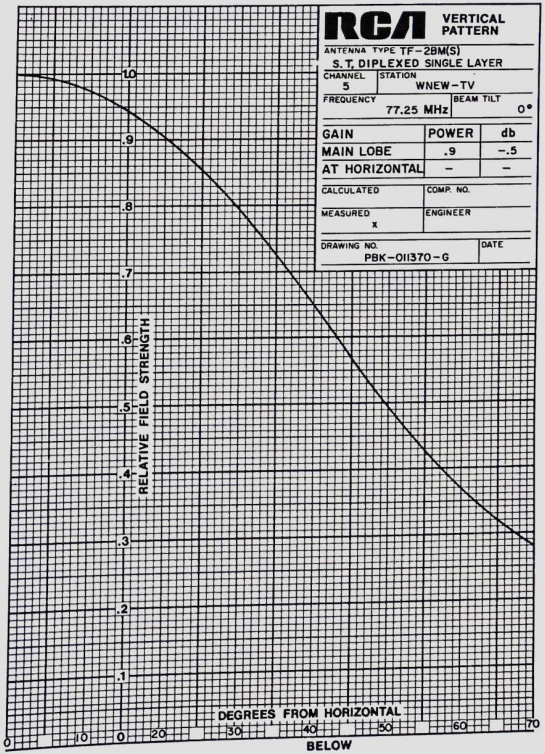
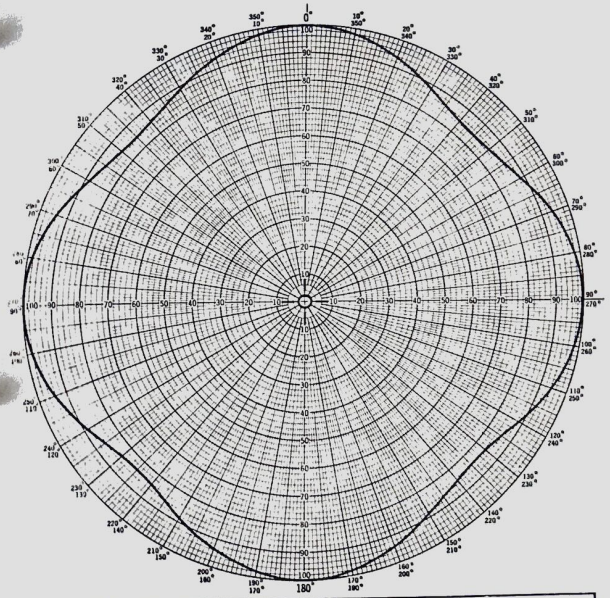
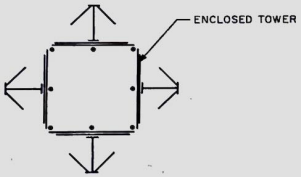

RCA
VERTICAL PATTERN
ANTENNA TYPE TF-28M(S)
S.T. DIPLEXED SINGLE LAYER
CHANNEL 5
STATION WNEW-TV
FREQUENCY 77.25 MHz
BEAM TILT 0°
GAIN | POWER | db
MAIN LOBE | .9 | -.5
AT HORIZONTAL | - | -
CALCULATED
COMP. NO.
MEASURED x
ENGINEER
DRAWING NO. PBK-011370-G
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
10
20
30
40
50
60
70
DEGREES FROM HORIZONTAL
BELOW

FIGURE 4-5.

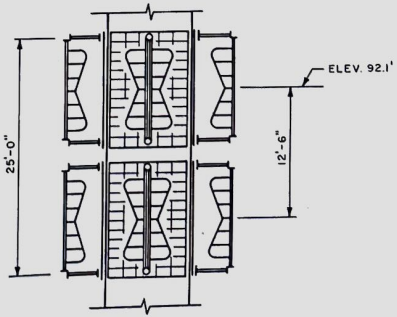


REMARKS	RCA
ANTICIPATED PATTERN	HORIZONTAL PATTERN
	ANT. TYPE TF-2BM (S) S.T. DIPLEXED
	CHANNEL 5 STATION WNEW-TV
	LOCATION "WTC", N.Y.C.
	FREQUENCY 77.25 MHz GAIN —
	DATE FEBRUARY 3, 1969
	Calculated — Comp. No. —
	Measured — Eng. D. A. B.
FIGURE 5-5	DRAWING NO. DAB 020369-B

WNBC-TV/WNEW-TV
CHANNELS 4/5
EMERGENCY ANTENNA



PLAN



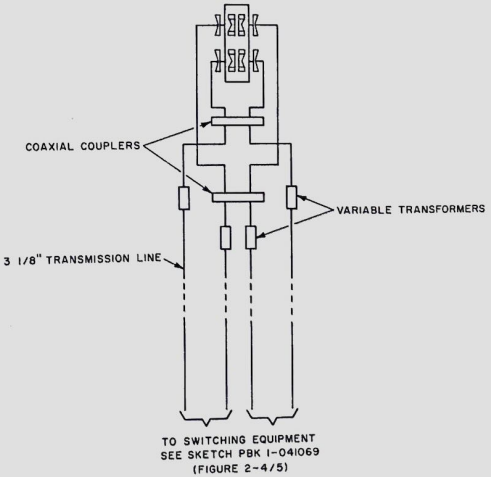
ELEVATION

EJB 700423-1

FIGURE 6-4/5

WNBC-TV/WNEW-TV
CHANNELS 4/5

DIPLEXED SUPERTURNSTILE
STANDBY ANTENNA
FEEDSYSTEM ARRANGEMENT



PBK-042470

FIGURE 7-4/5

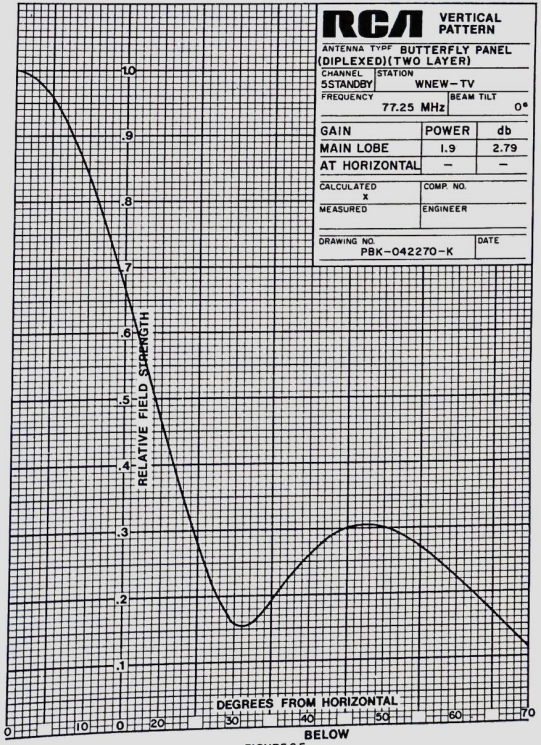

RCA
VERTICAL PATTERN
ANTENNA TYPE BUTTERFLY PANEL (DIPLEXED)(TWO LAYER)
CHANNEL 5STANDBY
STATION WNEW-TV
FREQUENCY 77.25 MHz
BEAM TILT 0°
GAIN | POWER | db
MAIN LOBE | 1.9 | 2.79
AT HORIZONTAL | — | —
CALCULATED x
COMP. NO.
MEASURED
ENGINEER
DRAWING NO. PBK-042270-K
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
10
20
30
40
50
60
70
DEGREES FROM HORIZONTAL
BELOW

FIGURE 8-5

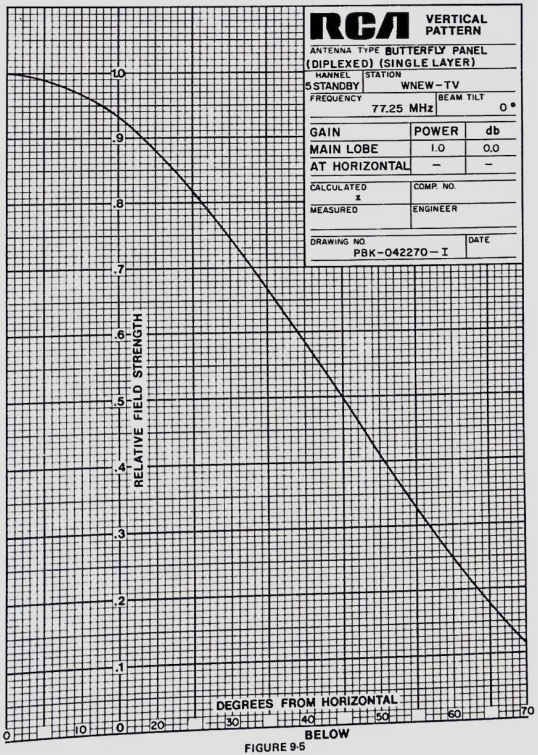
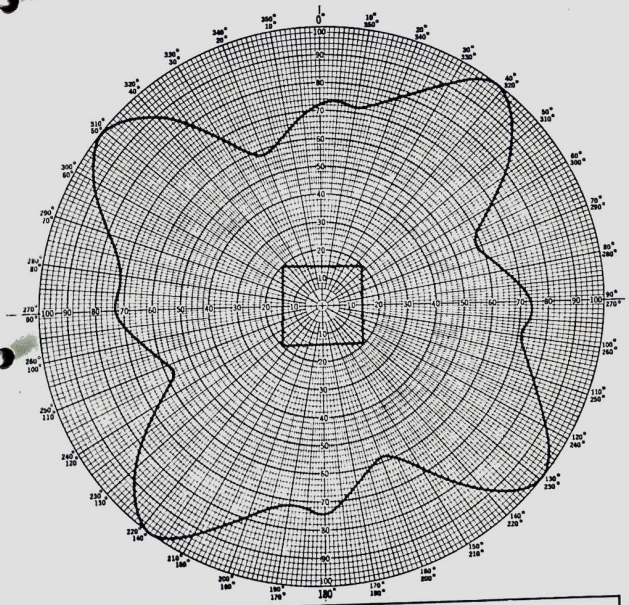

RCA
VERTICAL PATTERN
ANTENNA TYPE BUTTERFLY PANEL (DIPLEXED) (SINGLE LAYER)
CHANNEL 5 STANDBY
STATION WNEW-TV
FREQUENCY 77.25 MHz
BEAM TILT 0°
GAIN | POWER | db
MAIN LOBE | 1.0 | 0.0
AT HORIZONTAL | – | –
CALCULATED X
COMP. NO.
MEASURED
ENGINEER
DRAWING NO. PBK-042270-I
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
10
20
30
40
50
60
70
DEGREES FROM HORIZONTAL
BELOW

FIGURE 9-5



REMARKS	RCA
ANTICIPATED PATTERN REFER 1/15/68 OBD	HORIZONTAL PATTERN
	ANT. TYPE BUTTERFLY PANEL (DIPLEXED)
	CHANNEL 5 STANDBY STATION WNEW-TV
	LOCATION "WTC", N. Y. C.
	FREQUENCY 77.25 MHz GAIN —
	DATE
	Calculated ____ Comp. No. ____
	Measured ✓ Eng. OBD
FIGURE 10-5	DRAWING NO. PBK-042170-K

ABSORPTION FILTER
WNEW-TV
CHANNEL 5
MECHANICAL CONFIGURATION

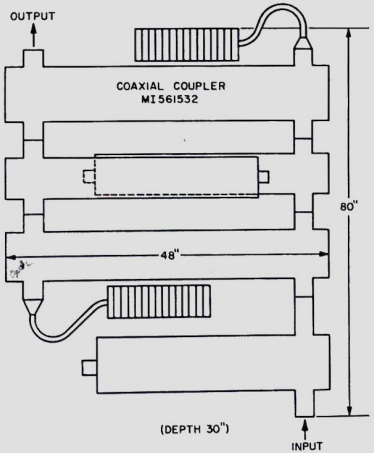


FIGURE 11-5

RCA No. _____ **SCHEDULE A** PAGE _____ OF _____

Table 3-5

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WNEW-TV - Channel 5		
				Transmission Line Requirements		
				<u>Main Antenna</u> (Two 3 1/8" Lines)		
		42	27791-D-1A	T/L, 3 1/8 x 20' 0"		
		2	27791-D-99	T/L, 3 1/8 x 17' 0"		
		4	27791-D-99	T/L, 3 1/8 x 10' 0"		
		2	27791-D-99	T/L, 3 1/8 x 9' 0"		
		2	27791-D-99	T/L, 3 1/8 x 8' 0"		
		2	27791-D-99	T/L, 3 1/8 x 6' 0"		
		2	27791-D-99	T/L, 3 1/8 x 3' 0"		
		34	27791-D-2A/2B	Coupling 90° elbow		
		2	27791-D	Gas stop		
		8	19313-44	Fixed hanger		
		66	19313-32	Expand hanger		
		4	27700	Inside hor. hanger kit		
		2	19313-17	Wall anchor, single		
		2	27791-D4B	Field Flange, male		

EDP 944

RCA No. _____ **SCHEDULE A** PAGE _____ OF _____

Table 5-5

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WNEW-TV - Channel 5		
				Transmission Line Requirements		
				<u>Standby Antenna</u>		
		24	27791-D-1A	T/L, 3 1/8 x 20' 0"		
		2	27791-D-99	T/L, 3 1/8 x 17' 0"		
		4	27791-D-99	T/L, 3 1/8 x 10' 0"		
		4	27791-D-99	T/L, 3 1/8 x 9' 0"		
		2	27791-D-99	T/L, 3 1/8 x 8' 0"		
		2	27791-D-99	T/L, 3 1/8 x 6' 0"		
		14	27791-D-2A/2B	Coupling 90° elbow		
		2	27791-D	Gas stop		
		8	19313-44	Fixed hanger		
		14	19313-32	Expand. hanger		
		4	27700	Inside horiz. hanger kit		
		2	19313-17	Wall anchor		
		2	27791-D-4B	Adaptor, male		

EDP 944

WABC-TV, Ch. 7 WOR-TV, Ch. 9 WPIX-TV, Ch. 11

SECTION VII APPENDIX 4

Equipment Description	Page	1-2
Auxiliary Equipment		3
Standby Antenna		4-5
Tests and Measurements		6-8
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Antenna Sketch	Figure	1-7
Vertical Pattern		2-7
Horizontal Pattern		3-7
Antenna Sketch (Standby)		4-7
Vertical Pattern (Standby)		5-7
Horizontal Pattern (Standby)		6-7
Specification Summary (Main)	Table	1-7
Specification Summary (Standby)		2-7
Transmission Line Equipment List (Main)		3-7
Transmission Line Equipment List (Standby)		4-7
Antenna Sketch (Optional Offering)	Figure	1-7
Vertical Pattern (Optional Offering)		2-7
Horizontal Pattern (Optional Offering)		3-7
Specification Summary (Main)(Optional Offering)	Table	1-7

WABC-TV

Channel 7

Equipment Description

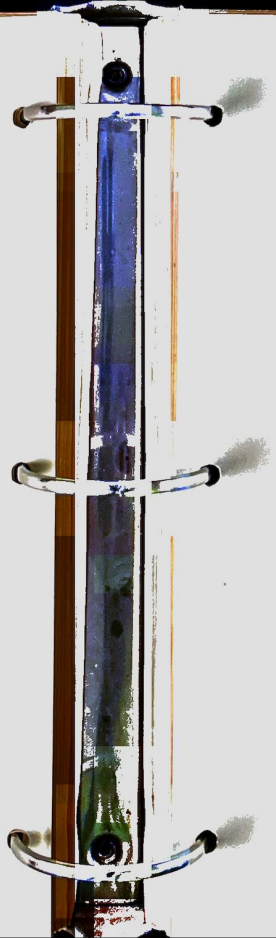
The antenna proposed is a single layer RCA Zee Panel type. It occupies the fourth position from the top of the World Trade Center Array. The antenna is designed for omnidirectional operation.

Mechanical

The antenna consists of four Zee Panel type radiating elements connected along their sides to each other and attached to the side of a square tower which supports the diplexed superturnstile antenna above it. The entire structure is protected by a radome which encloses it. The mechanical configuration is shown in Figure 1-7. The four radiating elements are fed by 3-1/8 inch rigid line from a four-way junction box located inside the shell, terminating a 6-1/8 inch 75 ohm coaxial transmission line that runs down the tower to the transmitter room.

A variable transformer accessible for tuning will be provided at a location as near as possible to the junction box.

A list of transmission line components estimated to be required from the antenna to the wall of the transmitter room is given in Table 3-7, herein. Correction will be made to actual needs after the layout is complete, with price to be adjusted according to list.



Transmission line components will be optimized as required to meet VSWR requirements.

The structure will be designed so as not to obstruct the Channel 7 RF field or encroach on the Channel 2/7 transition area.

The design will be such as to minimize undesirable effects due to contact of dissimilar metals.

Electrical

The anticipated vertical pattern is shown in Figure 2-7.
The anticipated horizontal pattern is given in Figure 3-7.

Decoupling between the Channel 7 antenna system and all other antennas will be -40 dB or better. For the measurement to demonstrate this, see "Tests and Measurements".

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 1-7.

Optional Offering

An optional approach is provided in the section titled Optional Offering which follows.

Auxiliary Equipment

Voltage Sampling

Provision will be made at the input to each panel for reflected voltage sampling in the lines back of the panel. Read-out will be provided in the transmitter room.

Ice Shields

A complete ice shield will be provided above the radome, and another (removable) one will be located inside the tower to protect the junction point and antenna feedlines if ice falls inside the tower.

System Pressurization

The system will be pressurized all the way to the panels, with bleeder lines to the transmitter room. For measurement of system pressure to meet specifications, see "Tests and Measurements".

WABC-TV

Channel 7

Standby Antenna

The antenna proposed is a two layer butterfly panel type, designed to provide omnidirectional service. It is mounted in the standby area below the FM antenna in the World Trade Center Array.

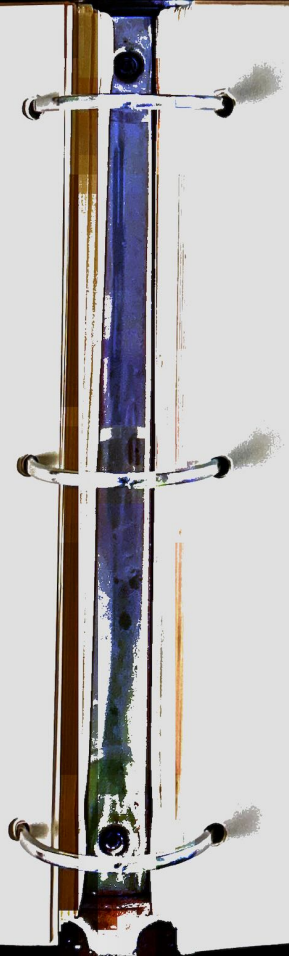
Mechanical

The antenna consists of eight butterfly panel radiators, mounted on the faces of the square section supporting tower. The panels are arranged in two layers, with four panels in each layer. Each panel is comprised of two batwing radiators, of the type used in the superturnstile antenna, mounted vertically side by side in front of the tower face.

A sketch of the mechanical configuration of the antenna follows in Figure 4-7.

Input to the antenna is provided by a single 6-1/8 inch coaxial line which divides two ways to feed equal power to two four-way junction boxes through 4-1/8 inch coaxial line. Each junction box feeds the four panels of a single layer through 1-5/8 inch heliax coaxial lines.

A variable transformer for fine matching is provided at the input to the antenna.



An estimate of transmission line components required between the antenna and the transmitter room is shown in Table 4-7. This list will be corrected upon final layout and the price adjusted at published list value.

Heaters are provided in the vertical risers of the radiating elements for deicing purposes.

Electrical

The calculated vertical pattern is shown in Figure 5-7, and the horizontal pattern in Figure 6-7.

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 2-7.

General Comments

It should be noted that the antenna VSWR of less than 1.05:1.0 is a valuable inherent design feature of RCA's offering, and is therefore indicated in the Table 2-7, even though no specification has been set forth.

Auxiliary Items

Ice Shields

The antenna will be mechanically protected from falling ice both inside and outside the tower.

WABC-TV

Tests and Measurements

A. Main Antenna

I. Design Consideration Prior to Shipment

The Zee panel antenna will be assembled at the RCA Antenna Engineering Center at Gibbsboro, New Jersey. Complete tests for the antenna will be performed prior to shipping. These include impedance measurements to meet the VSWR specification of 1.05:1, and horizontal and vertical pattern measurements including eight vertical sections. Antenna gain will be established from these pattern measurements. The antenna will be shipped completely assembled to the World Trade Center Building.

II. Prior to Erection

Prior to installation on the World Trade Center Building, visual inspection will be made of the antenna and the transmission lines to make sure that no damage has occurred during shipment.

III. During Erection

D. C. pulse measurements of the transmission line will be made during assembly to insure correct installation. This will be done at frequent intervals as the line is put in, using the standard method of rapping flanges with a rubber mallet at points of junction, to display the characteristic

spasmodic jump of the pulse if a poor joint has been made. Indications of greater than 1% pulse return, if not determined as intended impedance compensations, will be investigated and corrected. Undue pulse jumps will also be investigated.

IV. <u>After Erection</u>

a. The complete system will be pressurized to 10 lbs. and suitable measurements made to demonstrate that loss of pressure does not exceed 1 lb. in 24 hours, account being taken of changes in ambient temperatures. Such leakage limit is not to be exceeded for a period of 1 year from test.

b. Slotted line measurements of VSWR will be made at .25 MHz intervals across the Channel looking into the transmission line at the wall of the transmitter room. With a matched load at the antenna end of the line it will be demonstrated that the values do not exceed 1.06:1:0. With the line connected to the antenna, they will not exceed 1.1:1.0.

c. A standard RF pulse measurement will be made from the transmitter room after complete installation of transmission lines and antennas up to this point has been accomplished. After final optimization with the variable transformers, the measurement will demonstrate that the returning pulse from the antenna does not exceed 2.5% of the test pulse.

d. Decoupling measurements will be made between this antenna and all the other antennas. This will be done by measuring the magnitude of the received signal of each opposite antenna's picture carrier frequency as compared to a known magnitude of signal input to the opposite antenna. The specification requirements of -40 dB will be demonstrated to have been met.

e. Helicopter measurements will be made of the pattern of the main antenna in accord with the description given elsewhere in this proposal.

B. Standby Antenna

I. Prior to Erection

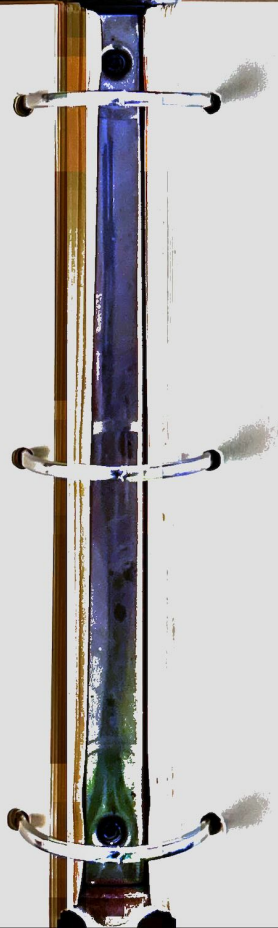
Same as for Main Antenna

II. During Erection

Same as for Main Antenna

III. After Erection

Electrical measurements shall be made as in A IV (a-d) above to demonstrate that feed system electrical characteristics for the standby antenna are the same as for the main antenna, except that if the transmission line is determined to be too short for proper RF pulse measurements, the standard RF sweep method used by the RCA Service Company will be used.



WABC-TV

Channel 7

Optional Offering

The antenna described in the previous pages will be designed to meet the requirements set forth on Pages 176 and 177 of the bid request. However, considerable improvement in circularity of the horizontal pattern is achieved if the four-sided zee panel type antenna is replaced by the RCA polygon antenna. The polygon antenna has been especially designed by RCA to meet a circularity of ± 1.1 dB or better. Horizontal pattern measurements using an exact scale model, have indicated that the circularity is less than ± 1.0 dB. Hence, the polygon antenna is provided here as an option with corresponding cost, in this proposal.

The polygon antenna consists of five Zee panels connected along their sides to each other and attached to the sides of a tower of pentagonal cross-section which supports the diplexed super-turnstile antenna above it. The entire structure is protected by a radome which encircles it. The mechanical configuration shown in Figure 1-7 (optional).

The five radiating elements are fed by a 3-1/8" rigid line from a five way junction box located inside the shell terminating the 6-1/8" coaxial transmission line that runs down the tower to the transmitter room.

The feed system is the same as that described in the primary offering.

Electrical

The anticipated vertical pattern is shown in Figure 2-7 (optional). The anticipated electrical pattern is shown in Figure 3-7 (optional).

Decoupling between Channel 7 antenna system and all other antennas will be -40 dB or better.For the measurement to demonstrate this, see Tests and Measurements (Primary Offering).

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 1-7 (optional).

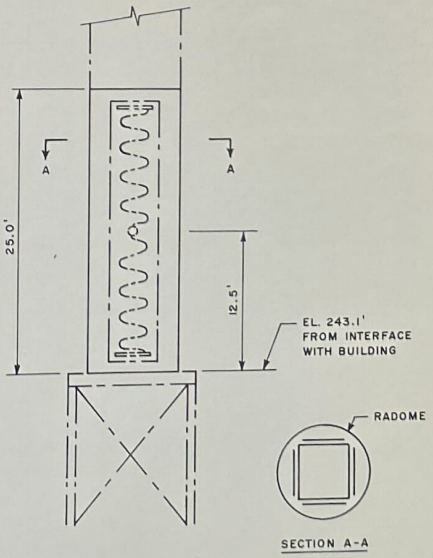
Auxiliary Items

Same as Primary Offering.

Tests and Measurements

Same as Primary Offering.

WABC-TV
CHANNEL 7
ZEE PANEL ANTENNA



EJB 700509-2

FIGURE 1-7

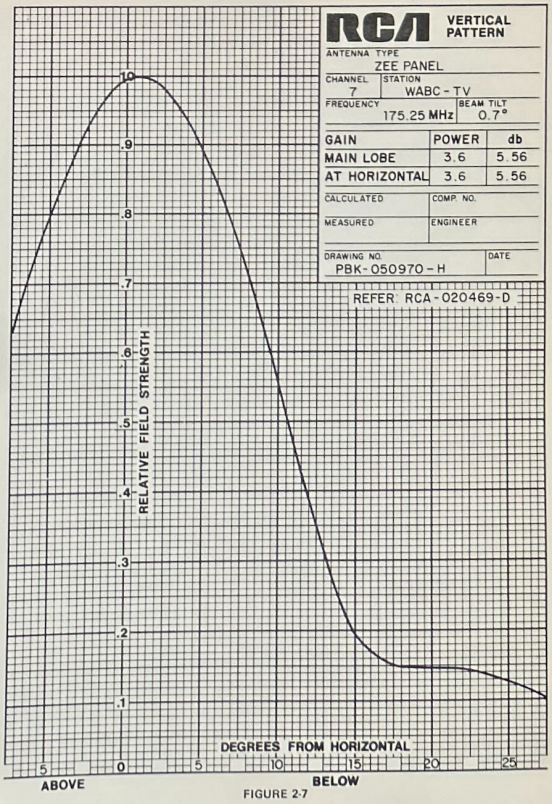
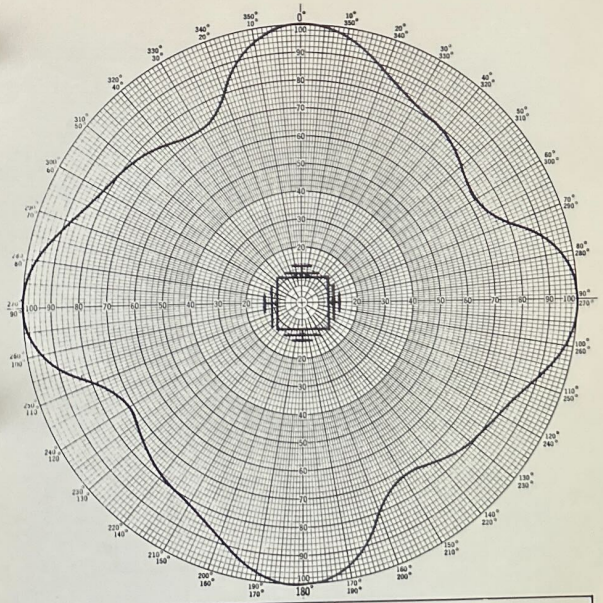
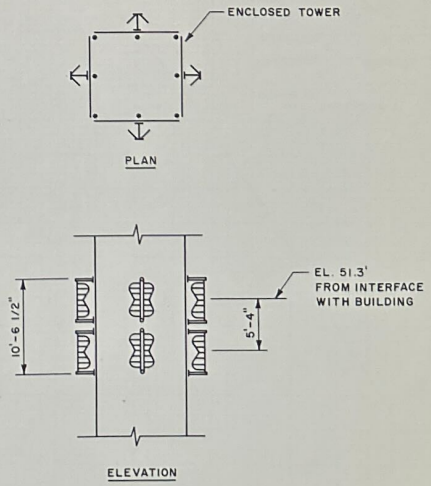

RCA
VERTICAL PATTERN
ANTENNA TYPE
ZEE PANEL
CHANNEL 7
STATION WABC-TV
FREQUENCY 175.25 MHz
BEAM TILT 0.7°
GAIN | POWER | db
MAIN LOBE | 3.6 | 5.56
AT HORIZONTAL | 3.6 | 5.56
CALCULATED
COMP. NO.
MEASURED
ENGINEER
DRAWING NO. PBK-050970-H
DATE
REFER: RCA-020469-D
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
DEGREES FROM HORIZONTAL
5
10
15
20
25
ABOVE
BELOW

FIGURE 2-7



REMARKS	RCA
REFER GEE-050467	HORIZONTAL PATTERN
	ANT. TYPE ZEE PANEL ANTENNA
	CHANNEL 7 STATION WABC-TV
	LOCATION "WTC", N.Y.C.
	FREQUENCY 175.25 MHz GAIN —
	DATE
	Calculated Comp. No.
	Measured X Eng.
FIGURE 3-7	DRAWING NO. PBK-050470-A

WABC-TV
CHANNEL 7
STANDBY ANTENNA



EJB-700427-3

FIGURE 4-7

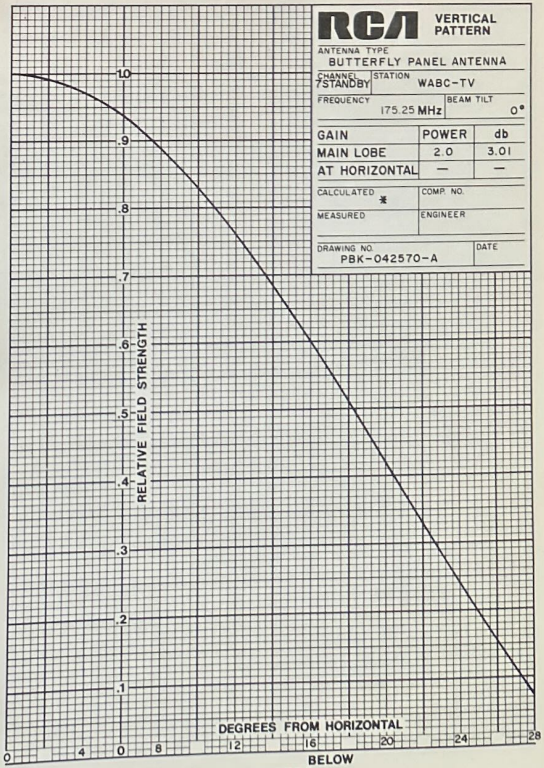
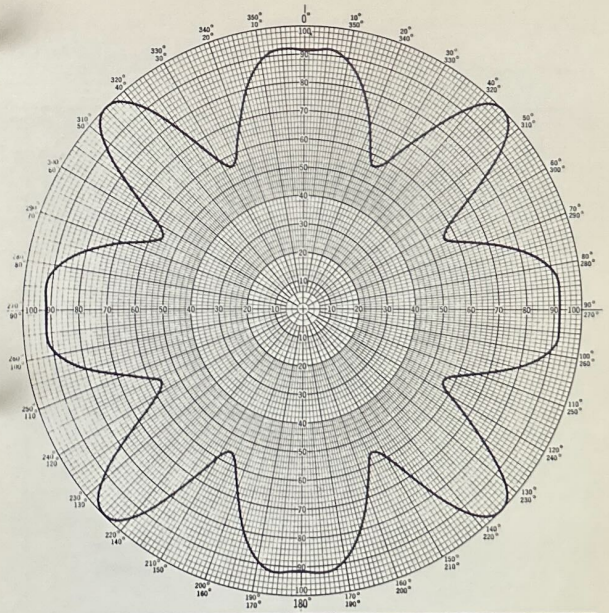

RCA
VERTICAL PATTERN
ANTENNA TYPE
BUTTERFLY PANEL ANTENNA
CHANNEL 7STANDBY
STATION WABC-TV
FREQUENCY 175.25 MHz
BEAM TILT 0°
GAIN | POWER | db
MAIN LOBE | 2.0 | 3.01
AT HORIZONTAL | — | —
CALCULATED *
COMP. NO.
MEASURED
ENGINEER
DRAWING NO. PBK-042570-A
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
DEGREES FROM HORIZONTAL
0
4
0
8
12
16
20
24
28
BELOW

FIGURE 5-7



REMARKS	RCA
ANTICIPATED PATTERN	HORIZONTAL PATTERN
	ANT. TYPE BUTTERFLY PANEL
	CHANNEL 7 STANDBY STATION WABC-TV
	LOCATION "WTC", N. Y. C.
	FREQUENCY 175.25 MHz GAIN —
	DATE
	Calculated Comp. No.
	Measured Eng.
FIGURE 6-7	DRAWING NO. PBK-042470-A

RCA No. _____ **SCHEDULE A** PAGE _____ OF _____

Table 3-7

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WABC-TV - Channel 7		
				Transmission Line Requirements		
				<u>Main Antenna</u> (One 6 1/8" Line)		
		21	27792-D-1A	T/L, 6 1/8 x 20' 0"		
		1	27792-D-99	T/L, 6 1/8 x 18' 0"		
		1	27792-D-99	T/L, 6 1/8 x 9' 6"		
		1	27792-D-99	T/L, 6 1/8 x 4' 6"		
		1	27792-D-99	T/L, 6 1/8 x 2' 0"		
		5	27792-D-2A/2B	Coupling 90° elbow		
		5	19314-44	Fixed hanger		
		24	19314-32	Expanding hanger		
		2	27701	Hor. fixed hanger kit		
		1	19314-48	Wall anchor		
		1	27792-D-3A	Gas stop		
		1	27792-D4B	Adaptor, male		

EDP 944

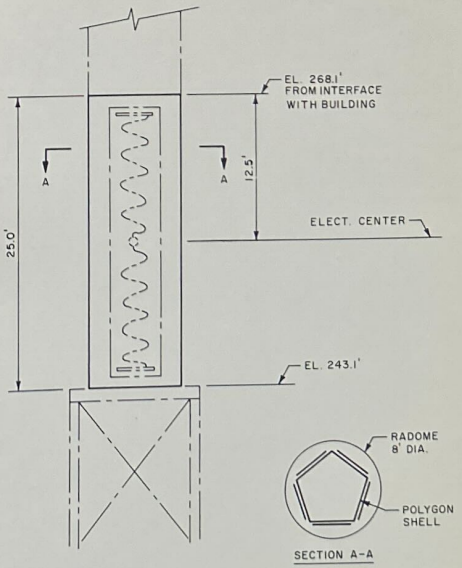
RCA No. _____ **SCHEDULE A** PAGE _____ OF _____

Table 4-7

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WABC-TV - Channel 7		
				Transmission Line Requirements		
				<u>Standby Antenna</u> (One 6-1/8" Line)		
		7	27792-D-1A	T/L, 6 1/8 x 20' 0"		
		1	27792-D-99	T/L, 6 1/8 x 18' 0"		
		1	27792-D-99	T/L, 6 1/8 x 13' 6"		
		1	27792-D-99	T/L, 6 1/8 x 9' 6"		
		1	27792-D-99	T/L, 6 1/8 x 4' 6"		
		5	27792-D-2A/2B	Coupling 90° elbow		
		1	27792-D-3A	Gas stop		
		4	19314-44	Fixed hanger		
		3	19314-32	Expand. hanger		
		2	27701	Inside horiz. hanger kit		
		1	19314-48	Wall anchor		
		1	27792-D-4B	Adaptor, male		

EDP 944

WABC-TV
CHANNEL 7
POLYGON ANTENNA



EJB 690201-4
REVISED 4/14/70

FIGURE 1-7 (OPTIONAL)

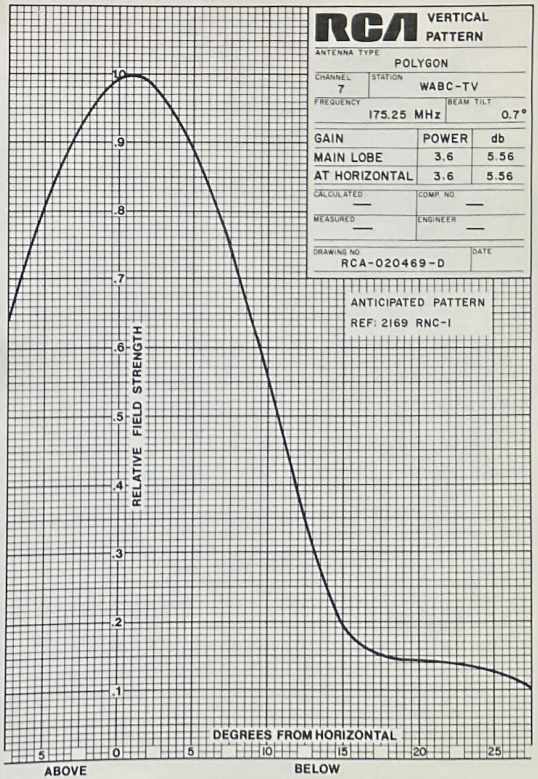
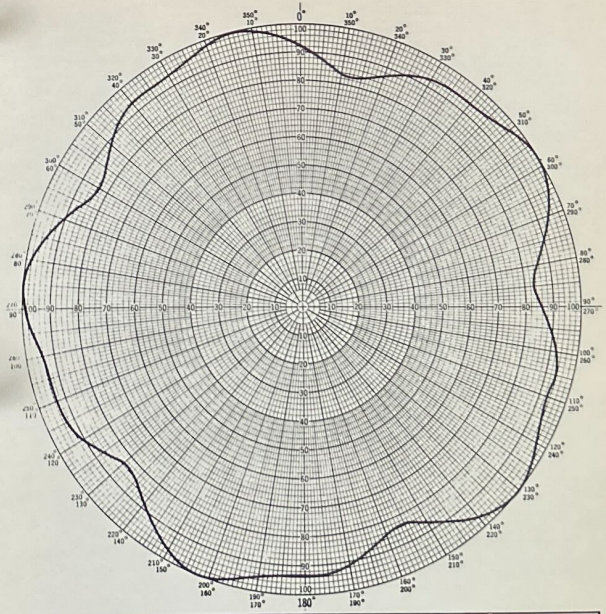


FIGURE 2-7 (OPTIONAL)



REMARKS	RCA
ANTICIPATED PATTERN	HORIZONTAL PATTERN
	ANT. TYPE POLYGON
	CHANNEL 7 STATION WABC-TV
	LOCATION "WTC", N.Y.C.
	FREQUENCY 175.25 MHz GAIN —
	DATE FEB. 1, 1969
	Calculated — Comp. No. —
REF. RNC-120767-2	Measured — Eng. —
FIGURE 3-7 (OPTIONAL)	DRAWING NO. RCA-020169-E

SECTION VII APPENDIX 5

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Standby Antenna		7-8
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Transmission Line Layout		2-9/13
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Antenna Sketch (Standby)		5-9
Vertical Pattern (Standby)		6-9
Horizontal Pattern (Standby)		7-9
Combiner Sketch		8-9/13
Specification Summary	Table	1-9
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WOR-TV

Channel 9

Equipment Description

The main antenna proposed is an RCA-6BH(s) Butterfly panel antenna diplexed for Channels 9 and 13. It is designed to operate with a power gain of 5.1 and an omnidirectional pattern. In the World Trade Center Array, the antenna occupies the third position from the top.

Mechanical

The antenna consists of eighteen Butterfly panel radiators affixed to the faces of the triangular tower structure. Each panel is comprised of two superturnstile type radiating elements supported, vertically, side by side, in front of a reflecting screen. Appropriate structural members are provided in the rear of the screen for attachment to supporting tower members. The panels are arranged in six layers with three panels per layer. The entire antenna will be enclosed by a radome.

A sketch of the mechanical configuration of the antenna is shown in Figure 1-9/13.

The radiators are fed by 3/4 inch styroflex feedlines. The nine feedlines from the top three layers of the antenna are fed from a junction box located inside the tower structure. The bottom three layers are fed from a second junction box

with a nine-way output. The two junction boxes are fed by 3-1/8 inch coaxial transmission lines.

The two 3-1/8 inch lines from the junction boxes are fed from a power dividing tee located inside the tower structure. This in turn is fed by a 6-1/8 inch coaxial transmission line carrying the signals of both channels from the combiner, located in the building. (The combiner is described under Auxiliary Equipment, below.)

The transmission line components required between the antenna and the transmitter room wall have been estimated and are shown in Table 3-9/13. This list will be revised to actual requirements after final layout. The price will be corrected at that time at published list values.

Isolation from the signal transmitted by Channel 13 is provided by the combiner and by an additional trap filter in the transmission line feeding the combiner from the Channel 9 transmitter. This is described in the Auxiliary Equipment section.

The feed system arrangement is shown in Figure 2-9/13.

Electrical

The calculated vertical pattern for the antenna is shown in Figure 3-9. A measured horizontal pattern of a similar antenna is shown in Figure 4-9. The horizontal pattern of

the antenna proposed is expected to be similar to that shown.

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 1-9.

General Comments

RCA's choice of the TBF-6BH Butterfly Panel antenna is based on providing a truly omnidirectional pattern and a low VSWR in diplexed operation. The anticipated circularity of ±1.5 dB for either of the two channels far exceeds the bid requirement of ±2 dB. The diplexed antenna will have a VSWR of less than 1.08:1 across the band for each channel. This valuable design feature is inherent in RCA's offering even though no specification is quoted in the bid request. The system will be designed for an RF pulse return of less than 2.5% compared to the bid specification of 3.0%.

Exceptions

It is felt that the use of the standard 6 1/8 inch coaxial transmission line with 75 ohm input impedance instead of the specified 50 ohm input impedance will not in any way affect the system performance. A 75 to 50 ohm adaptor will be furnished.

Auxiliary Equipment

A. Channel 9/13 Combiner

The unit which combines Channels 9 and 13 into a single transmission line feed to the antenna is a two-hybrid combiner. No resonant circuits are used.

The unit is composed of two 4-port hybrids, two phasing loops, and an absorbing resistor. Two ports of the first 4-port hybrid are connected to two ports of the second 4-port hybrid through the phasing loops. The two loops are unequal in length to such an extent that the difference in loop lengths is an odd multiple of half-wavelengths for one channel and an even multiple of half-wavelengths for the other channel. The other two adjacent ports on the first 4-port hybrid are the two inputs of the unit. The phasing of the loops is such that the signals from both inputs flow to one of the remaining ports on the second 4-port hybrid. This is the output port of the unit. The absorbing resistor is connected to the last remaining port, to absorb unbalance power due to loop runout across the 6 MHz bandwidth of each channel.

Since the combiner (and trap referred to below) will be in a heated and protected area, they will be designed for ungassed operation.

The electrical characteristics of the combiner are shown in Table 4-9/13

B. Isolation Traps

A high degree of isolation between Channels 9 and 13 will be obtained through the operation of the combiner. To ensure that the full 40 dB requirement is met, however, a trap filter in each of the lines coming from the transmitters (9 and 13) is included in this proposal. The unwanted low-level signal will be reflected back into the combiner and then appear at the resistor port where it will be absorbed.

C. Pressure Bleeding Facilities

A return bleeder line will be provided from a point in the transmission lines of the main and standby antennas, close to the antennas, to the WOR transmitter room. Demonstration of ability of the system to hold pressure will be as covered under "Tests and Measurements".

D. Ice Shield

An ice shield will be provided, to be installed above the main antenna.

E. Intercommunication

Intercommunication will be provided between the transmitter room and the main and standby antennas.

F. Voltage Sampling

Two coaxial RF sampling cables (RG-8 or equivalent) will be supplied to both the main and standby antennas. These cables will be long enough for termination in the transmitter room and will end in capped type-N chassis type fittings protected in a weatherproof box at the antenna terminals.

WOR-TV

Channel 9

Standby Antenna

The antenna proposed is a two layer Butterfly Panel type, designed to provide omnidirectional service. It is mounted in the standby area below the FM antenna in the World Trade Center Array.

Mechanical

The antenna consists of eight butterfly panel radiators, mounted on the faces of the square section supporting tower. The panels are arranged in two layers, with four panels in each layer. Each panel is comprised of two batwing radiators, of the type used in the superturnstile antenna, mounted vertically side by side in front of a screen.

A sketch of the mechanical configuration of the antenna follows in Figure 5-9.

Input to the antenna is provided by a single 6 inch coaxial line feeding a 3-1/8 inch eight-way power divider. Each panel is fed from this power divider through a 7/8 inch styroflex line. A variable transformer for fine matching is provided at the input to the antenna.

An estimate of transmission line components required between the antenna and the transmitter room is shown in Table 5-9.

This list will be corrected upon final layout and the price adjusted at published list value.

Heaters are provided in the vertical risers of the radiating elements for deicing purposes.

Electrical

The calculated vertical pattern is shown in Figure 6-9, and the horizontal pattern in Figure 7-9.

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 2-9.

General Comments

It should be noted that the antenna input VSWR of less than 1.05:1.0 is a valuable inherent design feature of RCA's offering and is, therefore, indicated in the table even though no specification has been set forth. Further, the system VSWR will be less than 1.1:1.0 compared to the bid specification of 1.14:1.0. The system will be designed for an RF pulse return of less than 2.5% compared to the bid specification of 3.5%.

Exception

It is felt that the use of the standard 6 1/8 inch coaxial transmission line with 75 ohm input impedance instead of the specified 50 ohm input impedance will not in any way affect the system performance. A 75 to 50 adapter will be furnished.

WOR-TV

Tests and Measurements

A. Main Antenna

I. Design Considerations Prior to Shipment

The antenna is a custom six layer Butterfly Panel type designed for providing diplexed operation. The antenna and feed system will be assembled at the RCA Antenna Engineering Center, Gibbsboro, New Jersey. Impedance measurements will be made and developed for a single panel in the presence of the adjacent two panels (above and below it). Such further impedance measurements will be made as are deemed necessary by RCA to meet the system specifications.

Both horizontal and vertical pattern measurements will be made of the full antenna and a report of the measured data will be prepared and submitted to the engineer. Although vertical pattern measurements are not required it is the present intention to make such a measurement for information purposes at the time the corresponding (required) measurements are made for Channel 13. As presently planned, the antenna, complete with its tower section, will be shipped, assembled, to the erection site.

II. Prior to Erection

Prior to installation on the World Trade Center Building, visual inspection will be made of the antenna and the transmission lines to make sure that no damage has occurred during shipment.

III. During Erection

D.C. pulse measurements of the transmission line will be made during assembly to ensure correct installation. This will be done at frequent intervals as the line is put in, using the standard method of rapping flanges with a rubber mallet at points of junction, to display the characteristic spasmodic jump of the pulse if a poor joint has been made. A specific value of return amplitude is not meaningful as certain portions of the system such as coaxial transformers and elbows are by nature narrow band and, therefore, produce (correctly) pulse return indications at the 0-50 MHz frequencies contained in the test pulses. Locations where returns are questionable will be investigated.

IV. After Erection

a. A standard RF pulse measurement (using a 0.25 microsecond pulse with a repetition rate of 15 KHz and a frequency of 187.26 MHz) will be made from the transmitter room wall after complete installation of transmission lines and

antennas up to this point has been accomplished. (It is assumed that the 9/13 combiner will be located between the wall and the antenna.) Optimization will be accomplished by adjustment of the variable transformer. The measurement will demonstrate that the returning pulse from the antenna does not exceed 2.5% of the test pulse.

b. VSWR measurements will be made at the wall of the transmitter room looking into the transmission line passing through the combiner and terminated in its related portion of the antenna to demonstrate that values not greater than the following have been obtained at the frequencies shown:

Visual Carrier	1.05
Color Subcarrier	1.10
Remainder of Band	1.14

c. The complete system will be pressurized to 10 lbs. using nitrogen gas and suitable measurements made to demonstrate that the gas leakage is not more than 5 psi in 30 days.

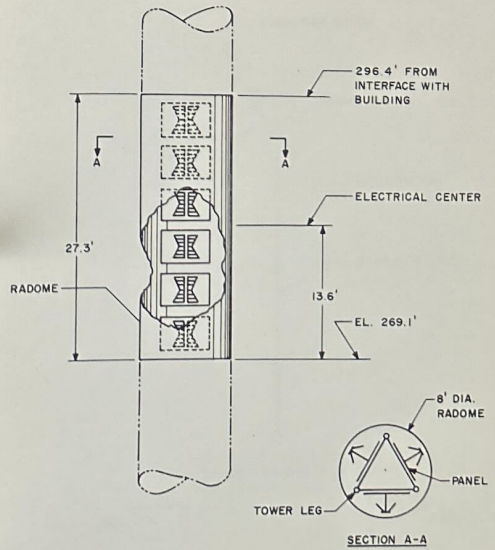
d. Measurements will be made to demonstrate that there is at least 40 dB of decoupling between the two diplexed channels.

e. Helicopter measurements will be made of the pattern of the main antenna in accord with the description given elsewhere in this proposal.

B. Standby Antenna

The measurements to demonstrate performance given in II, III, and IV (a-d) above will be made for the standby antenna, except that the RF pulse response shall be optimized by standard sweep technique if the transmission line is judged to be too short for RF pulse measurements.

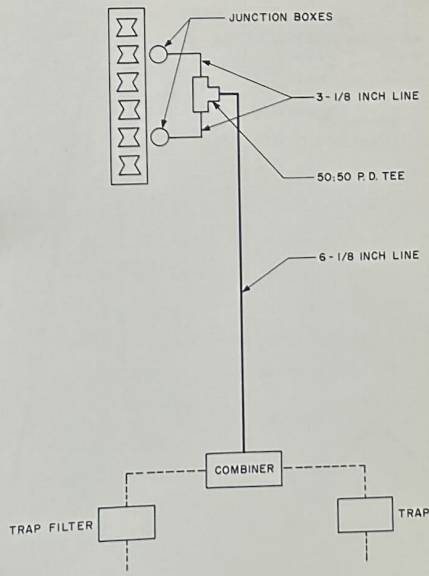
WOR-TV / WNDT-TV
CHANNELS 9/13
TBF-6H BUTTERFLY PANEL ANTENNA
(SPECIAL DIPLEXED)
MECHANICAL CONFIGURATION



EJB 690305-3

FIGURE 1-9/13

WOR-TV / WNDT-TV
CHANNELS 9/13
DIPLEXED BUTTERFLY PANEL ANTENNA
FEED SYSTEM ARRANGEMENT



PBK-050170-A

FIGURE 2-9/13

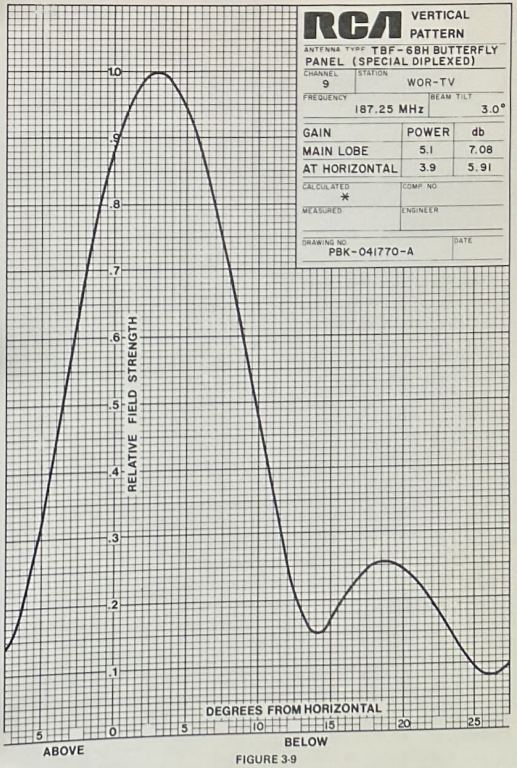
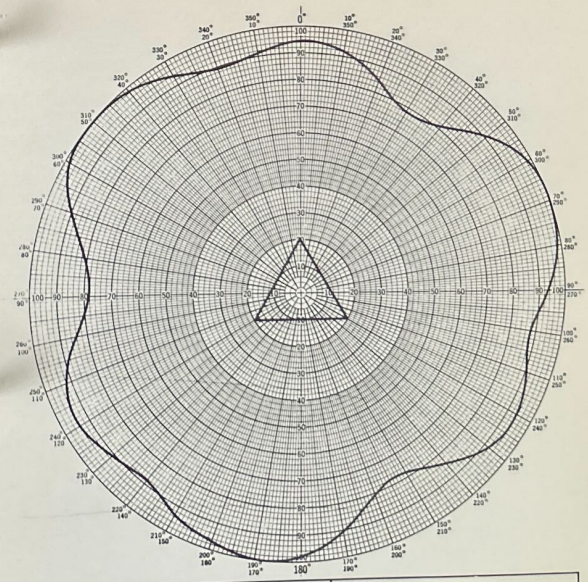
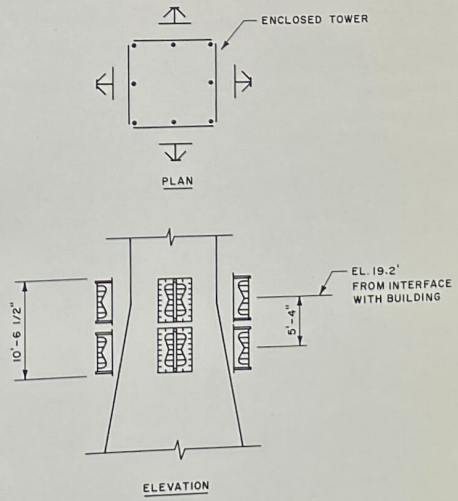

RCA
VERTICAL PATTERN
ANTENNA TYPE TBF-6BH BUTTERFLY PANEL (SPECIAL DIPLEXED)
CHANNEL 9
STATION WOR-TV
FREQUENCY 187.25 MHz
BEAM TILT 3.0°
GAIN | POWER | db
MAIN LOBE | 5.1 | 7.08
AT HORIZONTAL | 3.9 | 5.91
CALCULATED *
COMP. NO.
MEASURED
ENGINEER
DRAWING NO. PBK-041770-A
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
DEGREES FROM HORIZONTAL
5
5
10
15
20
25
ABOVE
BELOW

FIGURE 3-9



REMARKS	RCA
*AVERAGED	HORIZONTAL PATTERN
	ANT. TYPE TBF 6BH BUTTERFLY PANEL
	CHANNEL 9 STATION WOR-TV
	LOCATION "WTC", N.Y.C.
	FREQUENCY 187.25 MHz GAIN —
	DATE JANUARY 31, 1969
	Calculated — Comp. No. —
	*Measured 1-15-'69 Eng. R.N.C.
REF: 13169 RNC-1 FIGURE 4-9	DRAWING NO. RCA-013169-A

WOR-TV
CHANNEL 9
STANDBY ANTENNA



EJB-700427-2

FIGURE 5-9

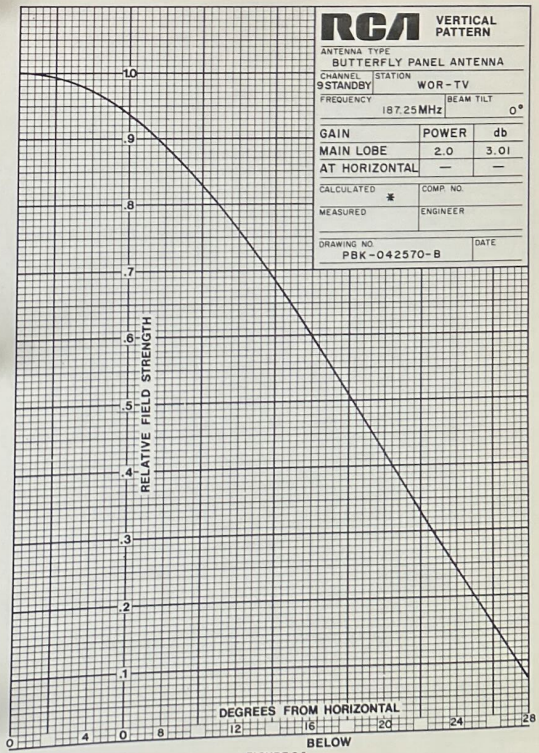
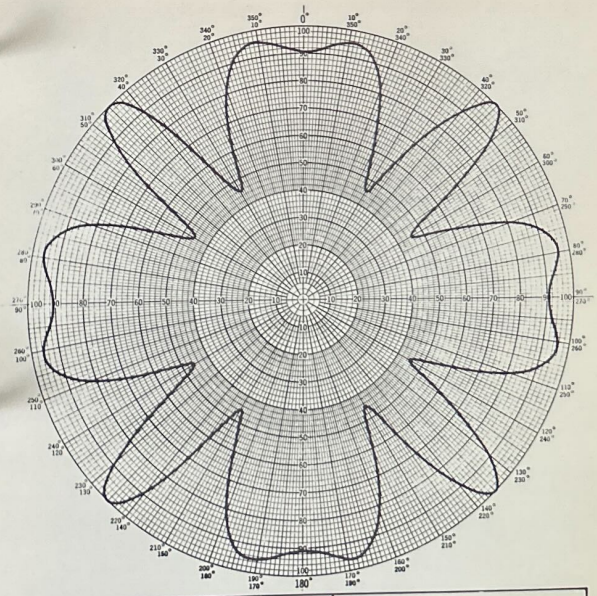

RCA
VERTICAL PATTERN
ANTENNA TYPE
BUTTERFLY PANEL ANTENNA
CHANNEL 9 STANDBY
STATION WOR-TV
FREQUENCY 187.25 MHz
BEAM TILT 0°
GAIN | POWER | db
MAIN LOBE | 2.0 | 3.01
AT HORIZONTAL | — | —
CALCULATED *
COMP. NO.
MEASURED
ENGINEER
DRAWING NO. PBK-042570-B
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
DEGREES FROM HORIZONTAL
4
0
8
12
16
20
24
28
BELOW

FIGURE 6-9



REMARKS	RCA
ANTICIPATED PATTERN	HORIZONTAL PATTERN
	ANT. TYPE BUTTERFLY PANEL
	CHANNEL 9 STANDBY STATION WOR-TV
	LOCATION "WTC", N.Y.C.
	FREQUENCY 187.25 MHz GAIN —
	DATE
	Calculated _____ Comp. No. _____
	Measured _____ Eng. _____
FIGURE 7-9	DRAWING NO. PBK-042470-B

COMBINER
WOR-TV / WNDT-TV
CHANNELS 9/13

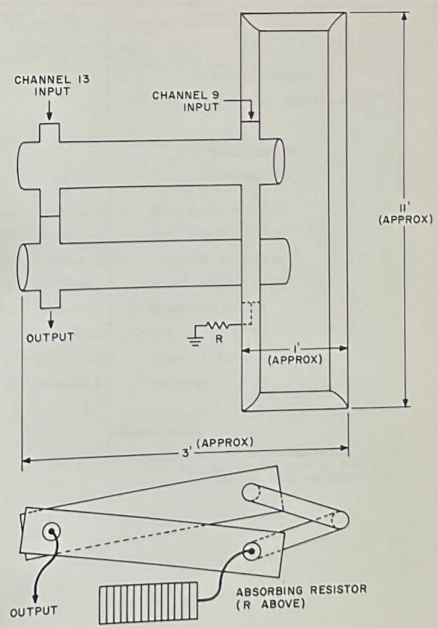


FIGURE 8-9/13

RCA No. _____ **SCHEDULE A** PAGE _____ OF _____

Table 3-9/13

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WOR-TV - Channel 9		
				Transmission Line Requirements		
				Main Antenna		
				Shared Line		
		14	27792-D-1A	T/L, 6 1/8 x 20' 0"		
		1	27792-D-99	T/L, 6 1/8 x 10' 0"		
		5	27792-D-2A/2B	Coupling 90° elbow		
		2	19314-44	Fixed hanger		
		29	19314-32	Expanding hanger		
		1	27792-D-99	T/L, 6 1/8 x 3' 0"		
		1	27792-D-4B	Adaptor, male		
		1	27792-D-3	Gas stop		
				PLEASE NOTE: The transmission line components listed on this page are duplicated in Table 3-13, but are priced only on this page.		

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FILTER COMBINER

CHANNELS 9/13

ELECTRICAL CHARACTERISTICS

VSWR (Each Input)*	1.03 Including Traps (With Matched Termination on Output)
Isolation (From Opposite Channel)	35 dB (Alone)* >40 dB (With Traps)
Power Input (Each Channel)	25 KW (Each Channel)
Efficiency*	97.5%

TRAP FILTERS

Isolation*	>5 dB
Power Input	25 KW
Efficiency*	98.5%

*To be measured during development at manufacturers site.

TABLE 4-9/13

RCA No. _____

SCHEDULE A

PAGE _____ OF _____

Table 5-9

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WOR-TV - Channel 9		
				Transmission Line Requirements		
				Standby Antenna (One 6-1/8" Line)		
		4	27792-D-1A	T/L, 6 1/8 x 20' 0"		
		2	27792-D- 99	T/L, 6 1/8 x 17' 0"		
		2	27792-D-99	T/L, 6 1/8 x 16' 0"		
		1	27792-D-99	T/L, 6 1/8 x 5' 0"		
		5	27792-D-2A/2B	Coupling, 90° elbow		
		1	27792-3A	Gas stop		
		5	19314-44	Fixed hanger		
		2	19314-32	Expand.hanger		
		1	27701	Horiz. fixed hanger kit		
		1	19314-48	Wall anchor		

EDP 944

SECTION VII APPENDIX 6

Equipment Descrpition	Page	1-2
Auxiliary Equipment		3
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Optional Proposal		10-11
Antenna Sketch	Figure	1-11
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Horizontal Pattern		3-11
Antenna Sketch (Standby)		4-11
Vertical Pattern (Standby)		5-11
Horizontal Pattern (Standby)		6-11
Specification Summary (Main)	Table	1-11
Specification Summary (Standby)		2-11
Transmission Line Equipment List (Main)		3-11
Transmission Line Equipment List (Standby)		4-11
Antenna Sketch (Optional Offering)	Figure	1-11
Vertical Pattern (Optional Offering)		2-11
Horizontal Pattern (Optional Offering)		3-11
Specification Summary (Main)(Optional Offering)	Table	1-11

WPIX-TV

Channel 11

Equipment Description

The antenna proposed is a single layer RCA polygon. It occupies the second position from the top of the World Trade Center Array. The antenna is designed for omnidirectional operation.

Mechanical

The antenna consists of four Zee-Panel type radiating elements connected along their sides to each other and attached to the sides of a square tower which supports the diplexed super-turnstile antenna above it. The entire structure is protected by a radome which encircles it. The mechanical configuration is shown in Figure 1-11.

The four radiating elements are fed by 3 1/8" rigid line from a four-way junction box located inside the shell terminating the 6 1/8" coaxial transmission line that runs down the tower to the transmitter room.

A variable transformer, accessible for tuning, will be provided at a location as near as possible to the junction box.

An estimate of transmission line components required between the antenna and the transmitter room is shown in Table 3-11. This list will be corrected upon final layout and the price adjusted at published list value.

Transmission line components will be optimized as required to meet VSWR requirements.

The design will be such as to minimize undesirable effects due to contact of dissimilar metals.

Electrical

The anticipated vertical pattern is shown in Figure 2-11. The anticipated horizontal pattern is given in Figure 3-11. This is a measured pattern of an identical type of antenna designed and built for WGN-TV, John Hancock Center, Chicago.

Decoupling between Channel 11 antenna system and all other antennas will be -40 dB or better. For the measurement to demonstrate this, see "Tests and Measurements".

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 1-11.

Optional Offering

An optional approach is provided in the section titled "Optional Offering" which follows.

Auxiliary Equipment

Voltage Sampling

Provision will be made at the input to each panel for reflected voltage sampling in the lines back of the panel. Read-out will be provided in the transmitter room.

Ice Shields

A complete ice shield will be provided above the radome, and another (removable) one will be located inside the tower to protect the junction point and antenna feedlines if ice fails inside the tower.

System Pressurization

The system will be pressurized all the way to the panels, with bleeder lines to the transmitter room. For measurement of system pressure to meet specifications, see "Tests and Measurements".

WPIX-TV

Channel 11

Standby Antenna

The antenna proposed is a two layer butterfly panel type, designed to provide omnidirectional service. It is mounted in the standby area below the FM antenna in the World Trade Center Array.

Mechanical

The antenna consists of eight butterfly panel radiators, mounted on the faces of the square section supporting tower. The panels are arranged in two layers, with four panels in each layer. Each panel is comprised of two batwing radiators, of the type used in the superturnstile antenna, mounted vertically side by side in front of the tower face.

A sketch of the mechanical configuration of the antenna follows in Figure 4-11.

Input to the antenna is provided by a single 6-1/8" coaxial line which divides two ways to feed equal power to two four-way junction boxes through 4-1/8" coaxial line. Each junction box feeds the four panels of a single layer through 1-5/8" heliax coaxial lines.

A variable transformer for fine matching is provided at the input to the antenna.

An estimate of transmission line components required between the antenna and the transmitter room is shown in Table 4-11. This list will be corrected upon final layout and the price adjusted at published list value.

Heaters are provided in the vertical risers of the radiating elements for deicing purposes.

Electrical

The calculated vertical pattern is shown in Figure 5-11 and the horizontal pattern in Figure 6-11.

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 2-11.

General Comments

It should be noted that the antenna VSWR of less than 1.05:1 is a valuable inherent design feature of RCA's offering and is, therefore, indicated in the table even though no specification has been set forth.

WPIX-TV

Tests and Measurements

A. Main Antenna

I. Design Consideration Prior to Shipment

The Zee panel antenna will be assembled at the RCA Antenna Engineering Center at Gibbsboro, New Jersey. Complete tests for the antenna will be performed prior to shipping. These include impedance measurements to meet the VSWR specifications of 1.05:1, and horizontal and vertical pattern measurements including eight vertical sections including correction for vertical polarization. Antenna gain will be established from these pattern measurements. The antenna will be shipped completely assembled to the World Trade Center Building.

The transmission line will be cut and optimized on the ground prior to installation.

II. Prior to Erection

Prior to installation on the World Trade Center Building, visual inspection will be made of the antenna and the transmission lines to make sure that no damage has occurred during shipment.

III. <u>During Erection</u>

DC Pulse measurements of the transmission line will be made during assembly to insure correct installation. This will be done at frequent intervals as the line is put in, using the standard method of rapping flanges with a rubber mallet at points of junction, to display the characteristic spasmodic jump of the pulse if a poor joint has been made. Indications of greater than 1% pulse return, if not determined as intended impendance compensations, will be investigated and corrected. Undue pulse jumps will also be investigated.

IV. <u>After Erection</u>

a. The complete system will be pressurized to 10 lbs. and suitable measurements made to demonstrate that loss of pressure does not exceed 1 lb., in 24 hours, account being taken of changes in ambient temperatures. Such leakage limit shall not be exceeded for a period of 1 year from test.

b. Slotted line measurements of VSWR will be made at .25 MHz intervals across the Channel looking into the transmission line at the wall of the transmitter room. With a matched load at the antenna end of the line, it will be demonstrated that the values do not exceed 1.06:1.0. With the line connected to the antenna, they shall not exceed 1.1:1.0.

c. A standard RF pulse measurement will be made from the transmitter room after complete installation of transmission lines and antennas up to this point has been accomplished.

After final optimization with the variable transformers, the measurement will demonstrate that the returning pulse from the antenna does not exceed 2.5% of the test pulse.

d. Decoupling measurements will be made between this antenna and all the other antennas. This will be done by measuring the magnitude of the received signal of each opposite antenna's

picture carrier frequency as compared to a known magnitude of signal input to the opposite antenna. The specification requirements of -40dB will be demonstrated to have been met.

e. Helicopter measurements will be made of the pattern of the main antenna in accord with the description given elsewhere in this proposal.

B. Standby Antenna

I. Prior to Erection

Same as for main antenna

II. During Erection

Same as for main antenna

III. After Erection

Electrical measurements shall be made as in A IV above to demonstrate that feed system electrical characteristics for the standby antenna are the same as for the main antenna, except that if the transmission line is determined to be too short for proper RF pulse measurements, the standard RF sweep method used by the RCA Service Company will be used.

WPIX-TV

Channel 11

Optional Proposal

The antenna described in the previous pages will be designed to meet the requirements set forth on pages 182 and 183 of the bid request. However, considerable improvement in circularity of the horizontal pattern is achieved if the four-sided Zee panel type antenna is replaced by the RCA polygon antenna.

The polygon antenna has been specially designed by RCA to meet a circularity of ±1.1 dB or better. Horizontal pattern measurements using an exact scale model have indicated that the circularity is less than ±1.0 dB. Hence, the polygon antenna is provided here as an option in the corresponding cost in the proposal.

The polygon antenna consists of five Zee panels connected along their sides to each other and attached to the sides of a tower of pentagonal cross-section which supports the diplexed super-turnstile antenna above it. The entire structure is protected by a radome which encircles it. The mechanical configuration is shown in Figure 1-11 (Optional).

The five radiating elements are fed by a 3 1/8" rigid line from a five-way junction box located inside the shell termi-

nating the 6 1/8" coaxial transmission line that runs down the tower to the transmitter room.

The feed system is the same as that described in the primary offering.

Electrical

The anticipated vertical pattern is shown in Figure 2-11 (optional).

The anticipated electrical pattern is shown in Figure 3-11 (optional).

Decoupling between Channel 11 antenna system and all other antennas will be -40 dB or better. For the measurement to demonstrate this see "Tests and Measurements" (primary offering).

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 1-11 (optional).

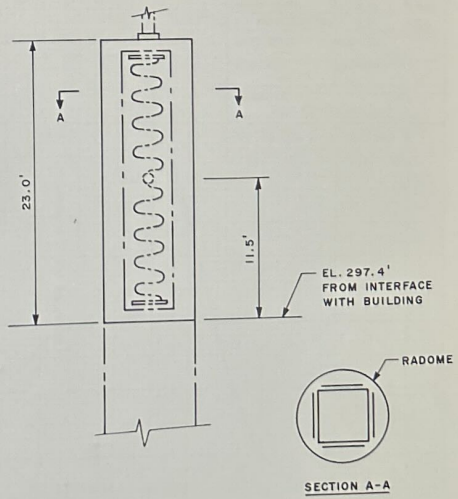
Auxiliary Items

Same as Primary Offering

Tests and Measurements

Same as Primary Offering.

WPIX-TV
CHANNEL 11
ZEE PANEL ANTENNA



EJB 700509-1

FIGURE 1-11

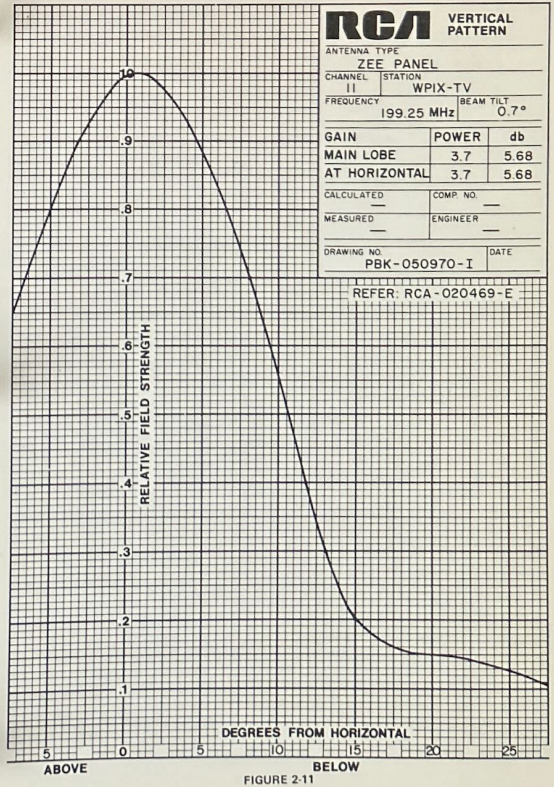
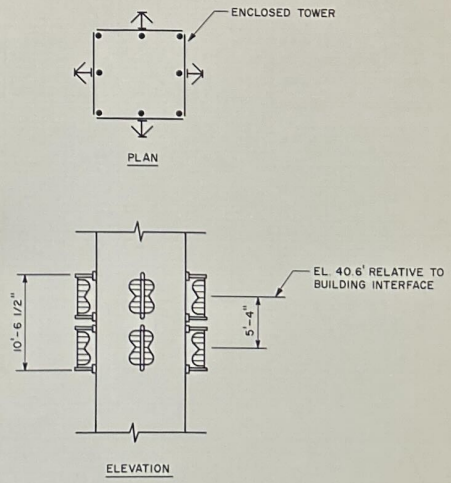

RCA
VERTICAL PATTERN
ANTENNA TYPE
ZEE PANEL
CHANNEL
11
STATION
WPIX-TV
FREQUENCY
199.25 MHz
BEAM TILT
0.7°
GAIN | POWER | db
MAIN LOBE | 3.7 | 5.68
AT HORIZONTAL | 3.7 | 5.68
CALCULATED
—
COMP. NO.
—
MEASURED
—
ENGINEER
—
DRAWING NO.
PBK-050970-I
DATE
REFER: RCA-020469-E
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
DEGREES FROM HORIZONTAL
5
5
10
15
20
25
ABOVE
BELOW

FIGURE 2-11

WPIX-TV
CHANNEL 11
STANDBY ANTENNA



EJB-700427-4

FIGURE 4-11

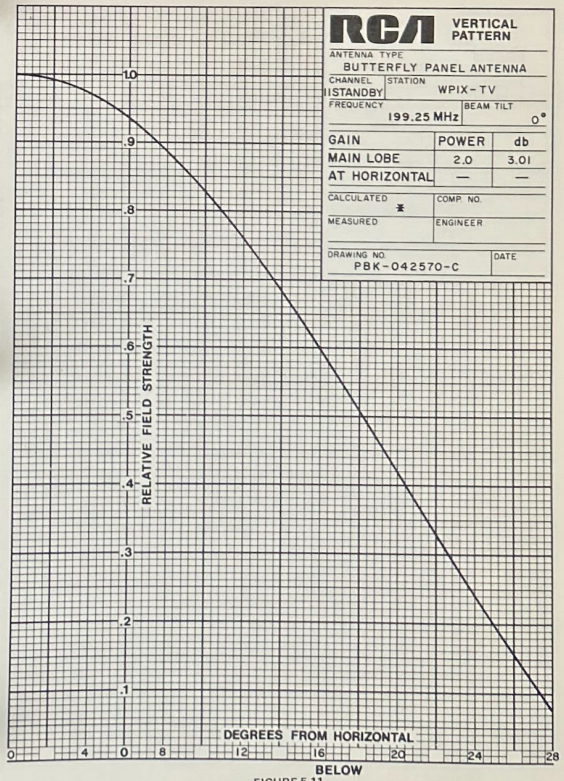

RCA
VERTICAL PATTERN
ANTENNA TYPE
BUTTERFLY PANEL ANTENNA
CHANNEL
11
STANDBY
STATION
WPIX-TV
FREQUENCY
199.25 MHz
BEAM TILT
0°
GAIN
POWER
db
MAIN LOBE
2.0
3.01
AT HORIZONTAL
—
—
CALCULATED
COMP. NO.
MEASURED
ENGINEER
DRAWING NO.
PBK-042570-C
DATE
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
RELATIVE FIELD STRENGTH
DEGREES FROM HORIZONTAL
0
4
0
8
12
16
20
24
28
BELOW

FIGURE 5-11

RCA No. _____ **SCHEDULE A** PAGE _____ OF _____

Table 4-11

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WPIX-TV - Channel 11		
				Transmission Line Requirements		
				<u>Standby Antenna</u> (One 6-1/8" Line)		
		5	27792-D-1A	T/L, 6 1/8 x 20' 0"		
		1	27792-D-99	T/L, 6 1/8 x 17' 0"		
		1	27792-D-99	T/L, 6 1/8 x 15' 0"		
		1	27792-D-99	T/L, 6 1/8 x 14' 0"		
		1	27792-D-99	T/L, 6 1/8 x 13' 6"		
		1	27792-D-99	T/L, 6 1/8 x 12' 0"		
		5	27792-D-2A/2B	Coupling, 90° elbow		
		1	27792-D	Gas stop		
		4	19314-44	Fixed hanger		
		3	19314-32	Expand. hanger		
		2	27701	Horiz. hanger kit		
		1	19314-48	Wall anchor		

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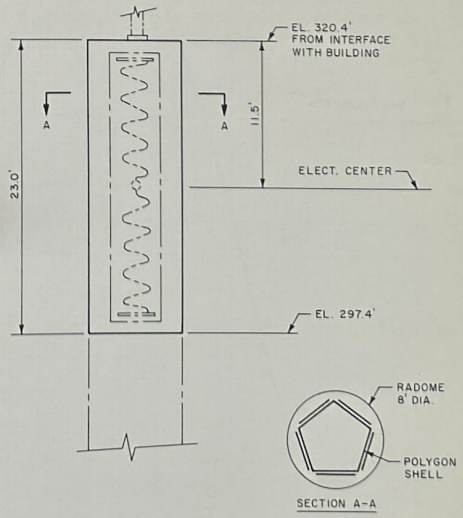
WPIX-TV
CHANNEL 11
POLYGON ANTENNA



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REVISED 4/14/70

FIGURE 1-11 (OPTIONAL)

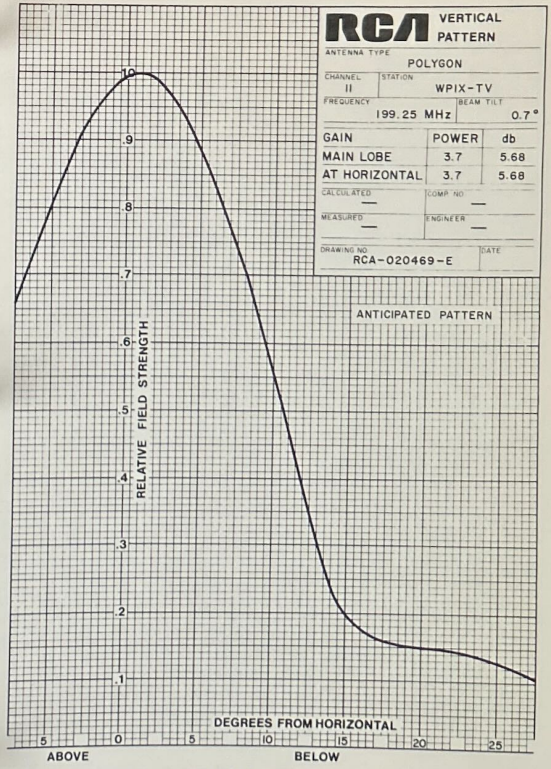

FIGURE 2-11 (OPTIONAL)

SECTION VII APPENDIX 7

Equipment Description	Page	1-3
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Horizontal Pattern		4-13
Antenna Sketch (Standby)		5-13
Vertical Pattern (Standby)		6-13
Horizontal Pattern (Standby)		7-13
Combiner Sketch		8-9/13
Specification Summary	Table	1-13
Specification Summary (Standby)		2-13
Transmission Line Equipment List (Main)		3-9/13
Combiner Specifications		4-9/13
Transmission Line Equipment List (Standby)		5-13

WNDT-TV

Channel 13

Equipment Description

The main antenna proposed is an RCA-6BH(S) Butterfly panel antenna diplexed for Channels 9 and 13. It is designed to operate with a power gain of 5.3 and an omnidirectional pattern. In the World Trade Center Array, the antenna occupies the third position from the top.

Mechanical

The antenna consists of eighteen Butterfly panel radiators affixed to the faces of the triangular tower structure. Each panel is comprised of two superturnstile type radiating elements supported, vertically, side by side, in front of a reflecting screen. Appropriate structural members are provided in the rear of the screen for attachment to supporting tower members. The panels are arranged in six layers with three panels per layer. The entire antenna will be enclosed by a radome.

A sketch of the mechanical configuration of the antenna is shown in Figure 1-9/13.

The radiators are fed by 3/4 inch styroflex feedlines. The nine feedlines from the top three layers of the antenna are fed from a junction box located inside the tower structure. The bottom three layers are fed from a second junction box with a nine-way output. The two junction boxes are fed by two 3-1/8 inch coaxial transmission lines.

The two 3-1/8 inch lines from the junction boxes are fed from a power dividing tee located inside the tower structure. This in turn is fed by a 6-1/8 inch coaxial transmission line carrying the signals of both channels from the combiner, located in the building. (The combiner is described in detail under "Auxiliary Equipment" below.)

The transmission line components required between the antenna and the transmitter room wall have been estimated and are shown in Table 3-9/13. This list will be revised to actual requirements after final layout. The price will be corrected at that time at published list values.

Isolation from the signal transmitted by Channel 9 is provided by the combiner and by an additional trap filter in the transmission line feeding the combiner from the Channel 13 transmitter. This is described in the Auxiliary Equipment section.

The feed system arrangement is shown in Figure 2-9/13.

Electrical

The calculated vertical pattern for the antenna is shown in Figure 3-13. A measured horizontal pattern of a similar antenna is shown in Figure 4-13. The horizontal pattern of the antenna proposed is expected to be similar to that shown.

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 1-13.

General Comments

RCA's choice of the TBF 6BH Butterfly Panel antenna is based on its high power gain of 5.3 compared to the specified value of 4.9, as well as good horizontal pattern circularity and low VSWR in diplexed operation. The anticipated circularity of ±1.5 dB for either of the two channels far exceeds the bid requirements of ±2 dB. The diplexed antenna will have a VSWR of less than 1.08:1 across the band for each channel. This valuable design feature is inherent in RCA's offering, even though no specification is quoted in the bid request. The system will be designed for an RF pulse return of less than 2.5% compared to the bid specification of 3.0%.

Exception

It is felt that the use of the standard 6 1/8 inch coaxial transmission line with 75 ohm input impedance instead of the specified 50 ohm input impedance will not in any way affect the system performance. A 75 to 50 ohm adaptor will be furnished.

WNDT-TV - Channel 13

Auxiliary Equipment

A. Channel 9/13 Combiner

The unit which combines Channels 9 and 13 into a single transmission line feed to the antenna is a two-hybrid combiner. No resonant circuits are used.

The unit is composed of two 4-port hybrids, two phasing loops, and an absorbing resistor. Two ports of the first 4-port hybrid are connected to two ports of the second 4-port hybrid through the phasing loops. The two loops are unequal in length to such an extent that the difference in loop lengths is an odd multiple of half-wavelengths for one channel and an even multiple of half-wavelengths for the other channel. The two other adjacent ports on the first 4-port hybrid are the two inputs of the unit. The phasing of the loops is such that the signals from both inputs flow to one of the remaining ports on the second 4-port hybrid. This is the output port of the unit. The absorbing resistor is connected to the last remaining port, to absorb unbalance power due to loop runout across the 6 MHz bandwidth of each channel.

Since the combiner (and trap referred to below) will be in a heated and protected area, they will be designed for ungassed operation.

Auxiliary Equipment (cont.)

The electrical characteristics of the combiner are shown in Table 4-9/13.

B. Isolation Traps

A high degree of isolation between Channels 9 and 13 will be obtained through the operation of the combiner. To ensure that the full 40 dB requirement is met, however, a trap filter in each of the lines coming from the transmitters (9 and 13) is included in this proposal. The unwanted low-level signal will be reflected back into the combiner and then appear at the resistor port where it will be absorbed.

C. Pressure Bleeding Facilities

A return bleeder line will be provided from a point in the transmission lines of the main and standby antennas, close to the antennas, to the transmitter room. Demonstration of ability of the system to hold pressure will be as covered under "Tests and Measurements".

D. Ice Shield

An ice shield will be provided, to be installed above the main antenna.

E. Intercommunication

Intercommunication will be provided between the transmitter room and the main and standby antennas.

Auxiliary Equipment (cont.)

F. Voltage Sampling

Two coaxial RF sampling cables, (RG-8 or equivalent) will be supplied to both the main and standby antennas. These cables will be long enough for termination in the transmitter room and will end in capped type-N chassis type fittings protected in a weatherproof box at the antenna terminals.

WNDT-TV

Channel 13

Standby Antenna

The antenna proposed is a two layer Butterfly Panel type, designed to provide omnidirectional service. It is mounted in the standby area below the FM antenna in the World Trade Center Array.

Mechanical

The antenna consists of eight Butterfly Panel radiators, mounted on the faces of the square section supporting tower. The panels are arranged in two layers, with four panels in each layer. Each panel is comprised of two batwing radiators, of the type used in the superturnstile antenna, mounted vertically side by side in front of the tower face.

A sketch of the mechanical configuration of the antenna follows in Figure 5-13.

Input to the antenna is provided by a single 6 inch coaxial line feeding a 3-1/8" eight-way power divider. Each panel is fed from this power divider through a 7/8 inch styroflex line. A variable transformer for fine matching is provided at the input to the antenna.

An estimate of transmission line components required between the antenna and the transmitter room is shown in Table 5-13.

This list will be corrected upon final layout and the price adjusted at published list value.

Heaters are provided in the vertical risers of the radiating elements for deicing purposes.

Electrical

The calculated vertical pattern is shown in Figure 6-13, and the horizontal pattern in Figure 7-13.

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 2-13.

General Comments

It should be noted that the antenna input VSWR of less than 1.05:1.0 is a valuable inherent design feature of RCA's offering and is therefore indicated in the table even though no specification has been set forth. Further, the system VSWR will be less than 1.1:1.0 compared to the bid specification of 1.14:1.0. The system will be designed for an RF pulse return of less than 2.5% compared to the bid specification of 3.0%.

Exception

It is felt that the use of the standard 6 1/8 inch coaxial transmission line with 75 ohm input impedance instead of the specified 50 ohm input impedance, will not in any way affect the system performance. A 75-50 adapter will be provided.

WNDT-TV

Tests and Measurements

A. Main Antenna

I. Design Considerations Prior to Shipment

The antenna is a custom six layer Butterfly Panel type designed for providing diplexed operation. The antenna and feed system will be assembled at the RCA Antenna Engineering Center, Gibbsboro, New Jersey. Impedance measurements will be made and developed for a single panel in the presence of the adjacent two panels (above and below it). Such further impedance measurements will be made as are deemed necessary by RCA to meet the system specifications.

Both horizontal and vertical pattern measurements will be made of the full antenna and a report of the measured data will be prepared and submitted to the engineer. As presently planned, the antenna, complete with its tower section, will be shipped, assembled, to the erection site.

II. Prior to Erection

Prior to installation on the World Trade Center Building, visual inspection will be made of the antenna and the transmission lines to make sure that no damage has occurred during shipment.

III. <u>During Erection</u>

D.C. pulse measurements of the transmission line will be made during assembly to ensure correct installation. This will be done at frequent intervals as the line is put in, using the standard method of rapping flanges with a rubber mallet at points of junction, to display the characteristic spasmodic jump of the pulse if a poor joint has been made. A specific value of return amplitude is not meaningful as certain portions of the system such as coaxial transformers and elbows are by nature narrow band and, therefore, produce (correctly) pulse return indications at the 0-50 MHz frequencies contained in the test pulses. Locations where returns are questionable will be investigated.

IV. <u>After Erection</u>

a. A standard RF pulse measurement (using a 0.25 microsecond pulse with a repetition rate of 15 KHz and a frequency of 187.26 MHz) will be made from the transmitter room wall after complete installation of transmission lines and antennas up to this point has been accomplished. (It is assumed that the 9/13 combiner will be located between the wall and the antenna.) Optimization will be accomplished by adjustment of the variable transformer. The measurement will demonstrate that the returning pulse from

the antenna does not exceed 2.5% of the test pulse.

b. VSWR measurements will be made at the wall of the transmitter room looking into the transmission line passing through the combiner and terminated in its related portion of the antenna to demonstrate that values not greater than the following have been obtained at the frequencies shown:

Visual Carrier	1.05
Color Subcarrier	1.10
Remainder of Band	1.14

c. The complete system will be pressurized to 10 lbs. using nitrogen gas and suitable measurements made to demonstrate that the gas leakage is not more than 5 psi in 30 days.

d. Measurements will be made to demonstrate that there is at least 40 dB of decoupling between the two diplexed channels.

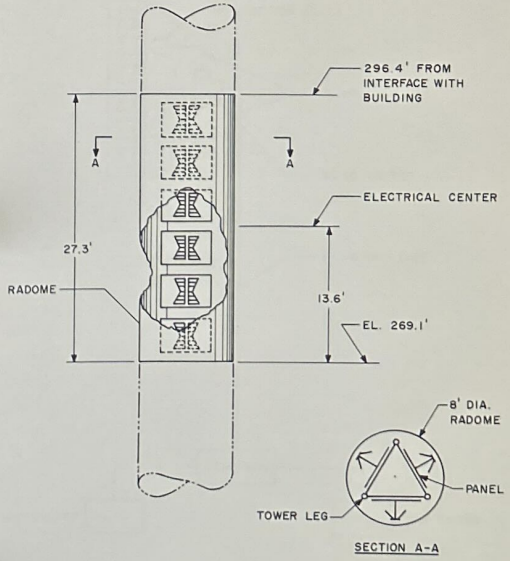
e. Helicopter measurements will be made of the pattern of the main antenna in accordance with the description given elsewhere in this proposal.

B. <u>Standby Antenna</u>

The same measurements to demonstrate performance given in II, III, and IV (a-d) above will be made for the standby antenna except that the RF pulse response shall be optimized

by standard sweep technique if the transmission line is judged to be too short for RF pulse measurements.

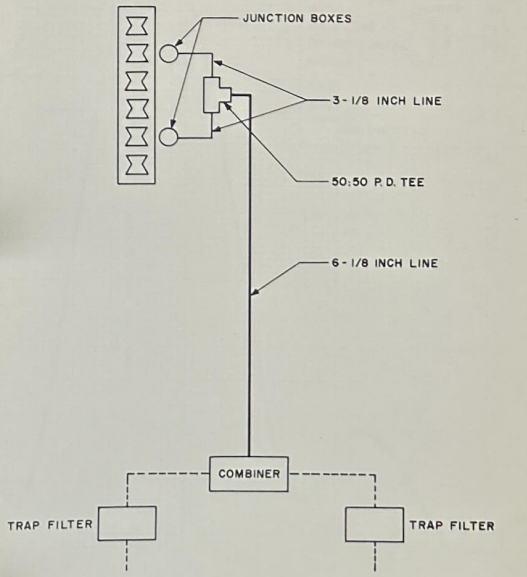
WOR-TV / WNDT-TV
CHANNELS 9/13
TBF-6H BUTTERFLY PANEL ANTENNA
(SPECIAL DIPLEXED)
MECHANICAL CONFIGURATION



EJB 690305-3

FIGURE 1-9/13

WOR-TV / WNDT-TV
CHANNELS 9/13
DIPLEXED BUTTERFLY PANEL ANTENNA
FEED SYSTEM ARRANGEMENT



PBK-050170-A

FIGURE 2-9/13

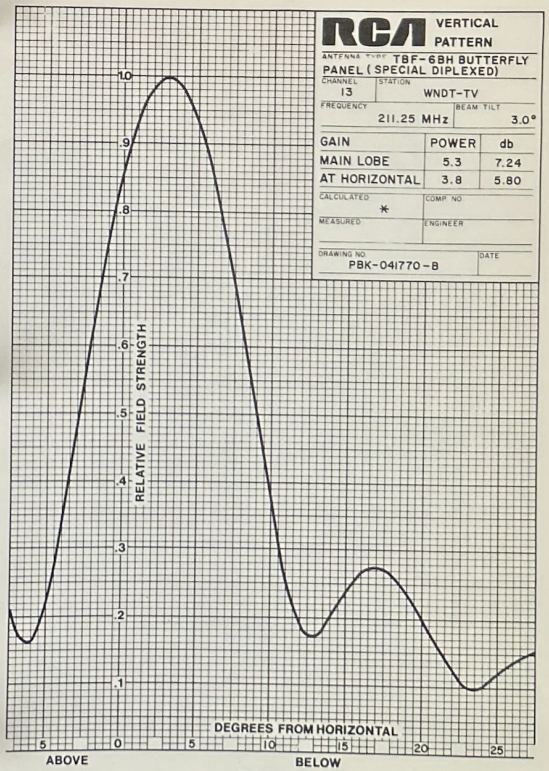
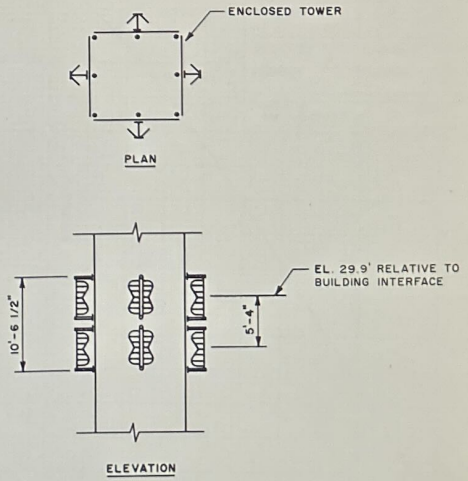

RCA
VERTICAL PATTERN
ANTENNA TYPE TBF-6BH BUTTERFLY PANEL (SPECIAL DIPLEXED)
CHANNEL 13
STATION WNDT-TV
FREQUENCY 211.25 MHz
BEAM TILT 3.0°
GAIN | POWER | db
MAIN LOBE | 5.3 | 7.24
AT HORIZONTAL | 3.8 | 5.80
CALCULATED *
COMP. NO.
MEASURED
ENGINEER
DRAWING NO. PBK-041770-B
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
DEGREES FROM HORIZONTAL
5
0
5
10
15
20
25
ABOVE
BELOW

FIGURE 3-13

WNDT-TV
CHANNEL 13
STANDBY ANTENNA



EJB-700427-5

FIGURE 5-13

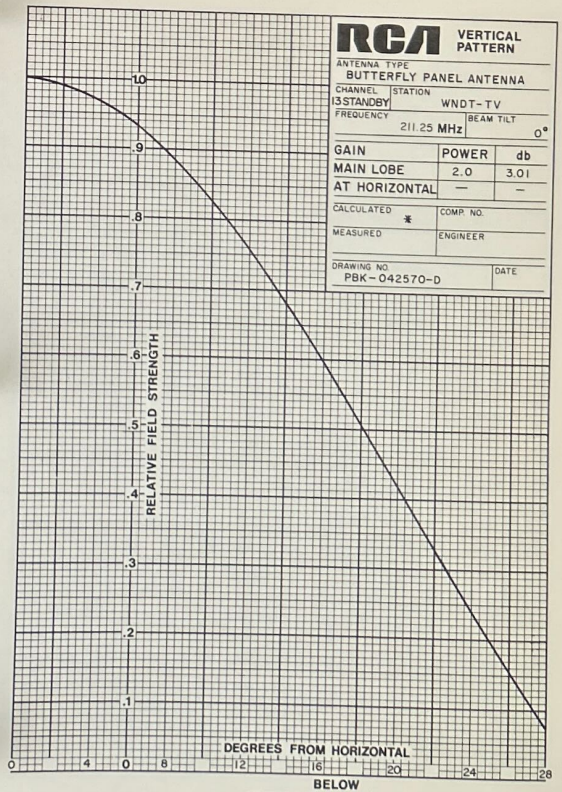

RCA
VERTICAL PATTERN
ANTENNA TYPE
BUTTERFLY PANEL ANTENNA
CHANNEL
13 STANDBY
STATION
WNDT-TV
FREQUENCY
211.25 MHz
BEAM TILT
0°
GAIN
POWER
db
MAIN LOBE
2.0
3.01
AT HORIZONTAL
—
—
CALCULATED
*
COMP. NO.
MEASURED
ENGINEER
DRAWING NO.
PBK-042570-D
DATE
RELATIVE FIELD STRENGTH
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
DEGREES FROM HORIZONTAL
0
4
0
8
12
16
20
24
28
BELOW

FIGURE 6-13

COMBINER
WOR-TV / WNDT-TV
CHANNELS 9/13

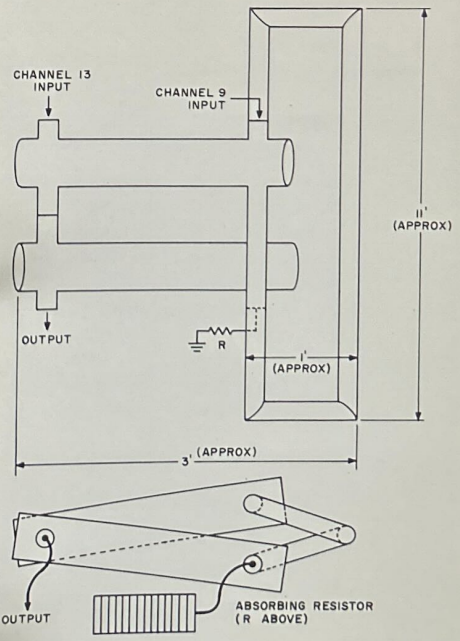


FIGURE 8-9/13

RCA No. _____ **SCHEDULE A** PAGE _____ OF _____

Table 3-9/13

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WNDT-TV - Channel 13		
				Transmission Line Requirements		
				<u>Main Antenna</u>		
				<u>Own Line</u>		
		6	27792-D-1A	T/L, 6 1/8 x 20' 0"		
		1	27792-D-99	T/L, 6 1/8 x 17' 0"		
		1	27792-D-99	T/L, 6 1/8 x 16' 0"		
		1	27792-D-99	T/L, 6 1/8 x 6' 6"		
		7	27792-D-2A/2B	Coupling 90° elbows		
		2	27792-D-3	Gas stop		
		5	19314-44	Fixed hangers		
		2	27701	Indoor Horiz. hanger kit		
		1	27792-D-4B	Adaptor, male		
		1	19314-48	Wall anchor		

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RCA No. _____

SCHEDULE A

PAGE _____ OF _____

Table 3-9/13

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WNDT-TV - Channel 13		
				Transmission Line Requirements		
				<u>Main Antenna</u>		
				<u>Shared Line</u>		
		14	27792-D-1A	T/L, 6 1/8 x 20'0"		
		1	27792-D-99	T/L, 6-1/8 x 10' 0"		
		5	27792-D-2A/2B	Coupling 90° elbow		
		2	19314-44	Fixed hanger		
		29	19314-32	Expanding hanger		
		1	27792-D-99	T/L, 6 1/8 x 3' 0"		
		1	27792-D-4B	Adaptor, male		
		1	27792-D-3	Gas stop		
				PLEASE NOTE:		
				The transmission line components listed on this page are in fact previously listed under Table 3-9 and are therefore not included in pricing.		

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FILTER COMBINER

CHANNELS 9/13

ELECTRICAL CHARACTERISTICS

VSWR (Each Input)*	1.03 Including Traps (With Matched Termination on Output)
Isolation (From Opposite Channel)	35 dB (Alone)* >40 dB (With Traps)
Power Input (Each Channel)	25 KW (Each Channel)
Efficiency*	97.5%

TRAP FILTERS

Isolation*	>5 dB
Power Input	25 KW
Efficiency*	98.5%

*To be measured during development at manufacturers site.

TABLE 4-9/13

RCA No. _____

SCHEDULE A

PAGE _____ OF _____

Table 5-13

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WNDT-TV - Channel 13		
				Transmission Line Requirements		
				<u>Standby Antenna</u>		
		7	27792-D-1A	T/L, 6 1/8 x 20' 0"		
		2	27792-D-99	T/L, 6 1/8 x 17' 0"		
		1	27792-D-99	T/L, 6 1/8 x 16' 0"		
		1	27792-D-99	T/L, 6 1/8 x 6' 6"		
		7	27792-D-2A/2B	Coupling, 90° elbow		
		1	27792-D3A	Gas stop		
		4	19314-44	Fixed hanger		
		2	19314-32	Expand. hanger		
		1	27701	Horiz. hanger kit		
		1	19314-48	Wall anchor		

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Vol. 2

SECTION VII APPENDIX 8

Equipment Description	Page	1-4
Tests and Measurements		5-7
Optional Offering		8-10
Antenna Sketch	Figure	1-31
Vertical Pattern (0.9° Beam Tilt)		2-31
Vertical Pattern (1.5° Beam Tilt)		3-31
Horizontal Pattern		4-31
Specification Summary	Table	1-31
Transmission Line Equipment List		2-31
Antenna Sketch (Optional Offering)	Figure	1-31
Horizontal Pattern (Optional Offering)		4-31
Specification Summary (Optional Offering)	Table	1-31

WNYC-TV

Channel 31

Equipment Description

The antenna proposed for Channel 31 is a Vee Zee Panel type antenna designed for directional service. It will be mounted on the legs of the triangular tower and will share the aperture with the Channel 2 antenna.

Mechanical

A total of fifteen Vee Zee panels will form the array of five layers with three panels in a layer. The panels are fed with a pressurized coaxial feed system. Waveguide-to-coax transitions are provided so that the antenna system may be fed with two WR1500 waveguides.

The components of the two WR1500 waveguides will be strengthened externally in the wide dimension by welded diagonal or crossed angle or channel sections.

Easy access to antenna elements will be provided. Access to all transmission line and waveguide connections will be provided without major disassembly of any radiating element, substantial disassembly of the 31 feed system, or any disturbance to the feed system of any other antenna on the same tower. Contact between aluminum and its alloys and copper and its alloys will be avoided in all parts of the antenna and feedline system.

Each Vee Zee panel will be individually radomed so that there will be no deicers required. A fiberglass ice shield will be provided above the aperture.

The radiating portion of the antenna will be divided and fed in two sections. The feed system will be such that either or both of the sections can be fed as a unit. Components to provide motorized switching are not provided under this proposal. They should be included in the transmitter contract.

A list of waveguide components, estimated to be required from the antenna input to the transmitter room wall is provided in Table 2-31. This list will be corrected to actual requirements upon final layout and the cost modified at published list price at that time. The transmission line system will be designed to operate under pressurization. Since the pressurizing equipment was specified under this contract, none has been supplied.

NOTE: TRANSMISSION LINE SYSTEM is pressurized by dehydrater system in WNYC space.

Electrical

The antenna will be designed and oriented to provide pattern characteristics as follows:

Horizontal Pattern

Directional, with center of minimum signal sector toward 145° Azimuth.

Each Vee Zee panel will be individually radomed so that there will be no deicers required. A fiberglass ice shield will be provided above the aperture.

The radiating portion of the antenna will be divided and fed in two sections. The feed system will be such that either or both of the sections can be fed as a unit. Components to provide motorized switching are not provided under this proposal. They should be included in the transmitter contract.

A list of waveguide components, estimated to be required from the antenna input to the transmitter room wall is provided in Table 2-31. This list will be corrected to actual requirements upon final layout and the cost modified at published list price at that time. The transmission line system will be designed to operate under pressurization. Since the pressurizing equipment was specified under this contract, none has been supplied.

NOTE: TRANSMISSION LINE SYSTEM IS pressurized by dehydrator system IN WNYC space.

Electrical

The antenna will be designed and oriented to provide pattern characteristics as follows:

Horizontal Pattern

Directional, with center of minimum signal sector toward 145° Azimuth.

In the maximum signal direction (from 205° to 85° True Azimuth) the signal will not fall more than 8.5 dB below the maximum value.

In the minimum signal direction (from 85° to 205° True Azimuth) the signal will not fall more than 12 dB below the pattern maximum.

The horizontal pattern shown as Figure 4-31 is based upon model measurements employing a single layer of the Channel 31 antenna mounted on a tower built to the same dimensions (scaled) as will be used. Although the Channel 2 antenna was not present, the changes are anticipated, on the basis of previous experience, to be small, and the above requirements will be met.

Vertical Pattern

The antenna elements will be so mounted and installed on the tower as to provide a vertical beam tilt on the beam nose of 1.5° in the minimum (145°) direction and 0.9° in the maximum (25° and 26.5°) directions. Calculated patterns for the two conditions are shown as Figures 3-31 and 2-31.

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 1-31.

The antenna gain in the maximum direction will be such as to provide an ERP of 5 megawatts with a 110 kw transmitter.

The antenna will be designed for a power handling capacity of 120 kw visual, and 10% aural on a continuous operation basis.

Optional Offering

An optional approach is provided in the section titled Optional Offering, which follows.

WNYC-TV

Channel 31

Tests and Measurements

I. Design Consideration Prior to Shipment

a. A single layer of three panels will be constructed on the same size tower as will be used on the World Trade Center Building. The butterfly panels of the Channel 2 antenna, sharing the same aperture, will be included. Horizontal pattern measurements on beam nose will be made to demonstrate that the previously described requirements under "Electrical" have been met. It is expected that they will be bettered by a considerable amount, with the relative field falling within the limits 0 to -6 dB from 205° to 85° and -3 dB to -10 dB from 85° to 205°.

b. The impedance of all panels and feed system components to be used in the array will be matched to ensure that the final impedance specification of the complete installed antenna can be met.

II. Prior to Erection

All panels and feed system components will be visually checked before installation on the tower to ensure that no shipping damage has been incurred.

III. After Erection

a. Impedance measurements will be carried out in the transmitter room at the input to each of the two waveguides feeding the antenna. The VSWR at these points will not exceed 1.1:1.

b. The complete feed system will be pressurized and necessary checks carried out to demonstrate that pressure is maintained.

c. Mutual coupling measurements will be made to demonstrate that de-coupling between the Channel 31 antenna array and other antennas on the tower is at least 45 dB.

d. Following complete installation of all the antennas on the tower, field strength measurements will be carried out by helicopter to indicate agreement with the pattern measured, as outlined under a separate portion of this proposal.

NEVER DONE

Exceptions

Exception is being taken for the specification in paragraph 6 on page ~~186~~ 189 of the bid request. In this paragraph the VSWR requirement for the antenna alone is given. Due to the construction of the feed system, and the fact that the antenna is assembled in the form in which a composite measurement of

this type cannot be made, no direct proof of compliance is practical. However, the other test measurements will adequately and effectively demonstrate the proper operation of the antenna.

WNYC-TV
Channel 31

Optional Offering

The antenna described in the previous pages will be designed to meet the requirements set forth on page 189 of the bid request. However, it is possible to incorporate modifications which will improve the horizontal pattern characteristics appreciably. An option is therefore being provided, with corresponding cost, in this proposal.

It has been determined that the serrations in the horizontal pattern can be considerably reduced when the tower support structure is covered with a metal skin all around. The improvement in the horizontal pattern is shown in the section describing the antenna.

Support tower is not covered with metal skin.

The physical description of the antenna as set forth in the primary offering is not changed since the components affected were not detailed. However, the paragraph headed "Electrical" will read as follows:

Electrical

The antenna will be designed and oriented to provide pattern characteristics as follows:

Horizontal Pattern

Directional, with center of minimum signal sector toward 145° azimuth.

In the maximum signal direction (from 205° to 85° True Azimuth) clockwise the signal will not fall more than 6 dB below the maximum value.

In the minimum signal direction (from 85° to 205° True Azimuth) clockwise the signal will not fall more than 10 dB below the pattern maximum nor rise to more than 3 dB below that maximum.

Over 75% of the horizontal pattern, the maximum value will not vary from the minimum value in any 20° sector by more than 2 dB, and over 90% it will not vary in any 20° sector by more than 2.5 dB.

The horizontal pattern shown as Figure 4-31 is based upon model measurements employing a single layer of the Channel 31 antenna mounted on a tower built to the same dimensions (scaled) as will be used. Although the Channel 2 antenna was not present, the changes are anticipated, on the basis of previous experience, to be small, and the above requirements will be met.

Vertical Pattern

The antenna elements will be so mounted and installed on the tower as to provide a vertical beam tilt on the beam nose of 1.5° in the minimum (145°) direction and 0.9° in the maximum (25° and 26.5°) directions. Calculated patterns for the two conditions are shown as Figures 3-31 and 2-31.

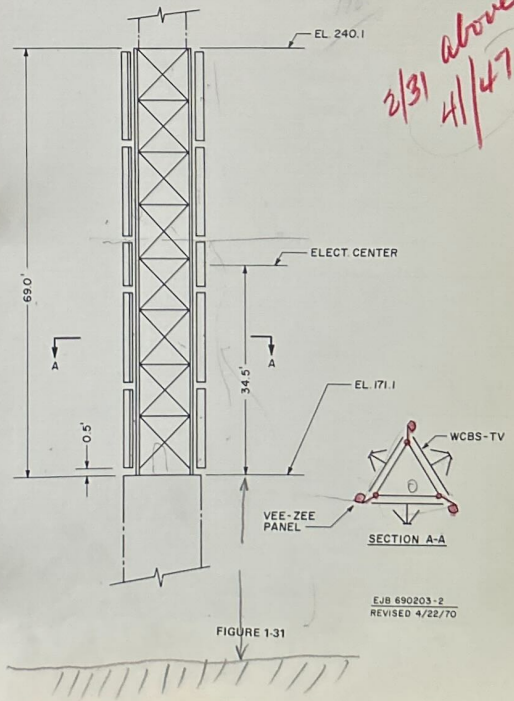
Specifications

The mechanical arrangement of the antenna is shown as Figure 1-31 (Optional).

The anticipated horizontal pattern is shown as Figure 4-31 (Optional).

A summary of mechanical and electrical characteristics is given as Table 1-31 (Optional).

WNYC-TV CHANNEL 31
VEE-ZEE PANEL ANTENNA
MECHANICAL ARRANGEMENT



EJB 690203-2
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FIGURE 1-31

3/31 above
4/1/47

* strikes ground 11.5 miles away

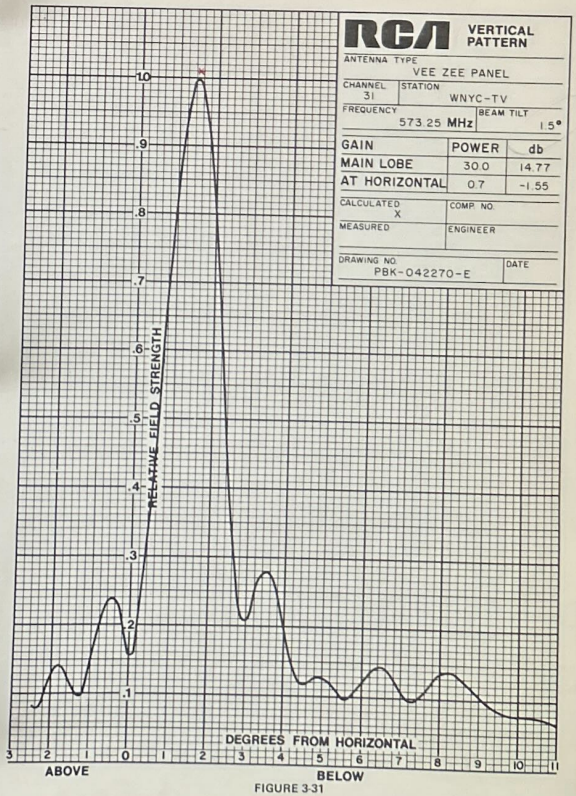

FIGURE 3-31

*strikes ground 17 miles away

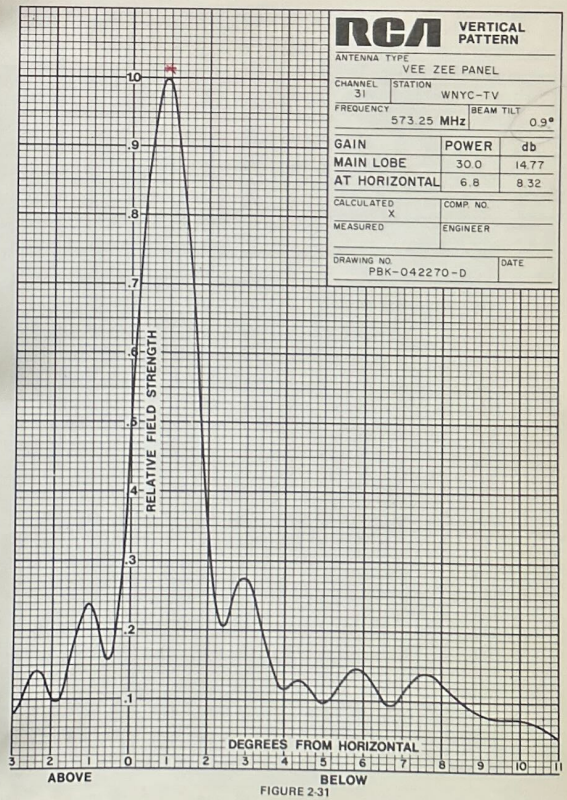

FIGURE 2-31

RCA No. _____

SCHEDULE A

Table 2-31

PAGE _____ OF _____

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WNYC-TV - Channel 31		
				Transmission Line Requirements		
				Main Antenna (Two WR-1500 Waveguides)		
		64	561620-B	WR-1500 Waveguide 11' 5"		
		6	561620-2A	90° Sweep elbow		
		2	561620-4B	Transition 6 1/8" male (27792-D)		
		28	561625-3A	Horizontal Expansion Hangers		
		35	561625-2A	Vertical Expansion Hanger		
		2	561625-1A	Fixed Hanger		
		4	561620-3A	Gas stop		

2/31 ABOVE 41/47

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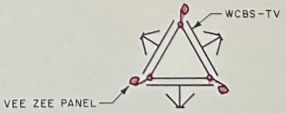
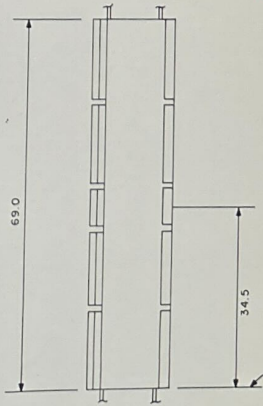
WNYC-TV (CH 31)
VEE ZEE PANEL ANTENNA



PLAN

2/31 above
41/47



ELEVATION

EJB690203-2
REVISED 4/22/70

(OPTIONAL) FIGURE 1-31

SECTION VII APPENDIX 9

Equipment Description	Page	1 - 6
Auxiliary Equipment		7 - 8
Tests and Measurements		9 -14
Antenna Sketch	Figure	1-41/47
Combiner Sketch		2-41/47
Vertical Pattern		3-41
Horizontal Pattern		4-41/47
Specification Summary	Table	1-41
Transmission Line Equipment List		2-41
Combiner Specifications		3-41/47

WXTV-TV

Channel 41

Equipment Description

The antenna proposed is a special cylindrical array of Mark III type panels mounted on a tower structure and designed for directional operation. It will occupy the space allocated for the joint use of Channels 41 and 47 below the Channel 2 and Channel 31 aperture. Channel 41 will share the same antenna with Channel 47 through diplexing circuitry.

Mechanical

The basic Mark III panel is a simplified arrangement of six broadband radiators of approximately one wavelength width. A balanced strip line is utilized to feed the radiators. The panels will be fed at the center from a single pressurized feed point. There will be seven vertical layers of panels with a maximum of twenty panels in each layer in the complete antenna system. The actual number of panels in a layer will be optimized during the horizontal pattern development carried out to meet the pattern specifications.

The antenna will be divided into two portions for emergency operation - a four-layer portion and a three-layer portion. The transmission line feed from the combiner/switching

equipment to each portion of the antenna will be parallel 8-3/16 inch universal type transmission lines for a total of four lines. The transmission line feed to the combiner/switching equipment from the transmitter room will be single 8-3/16 inch universal transmission lines rated at over 100% of the channel full power capability.

An estimate of transmission line required is given in Table 3-41. This list will be corrected to actuals after final layout and the price adjusted at that time to published list values.

Antenna will withstand without damage a wind pressure equivalent to that specified for Tower A Tower Support Structure.

Antenna feed lines, junction boxes and hardware will be constructed of materials suitable for continuous operation in marine environment. Copper outer conductors will be used for all feedlines. Steel components will be properly galvanized or of stainless steel. Junctions of dissimilar metals will be avoided or protected to prevent electrolysis.

Mechanical protection against falling ice will be provided by screens above the radome or by other methods. All pattern and impedance tests will be made with ice protectors in place. If the structure permits ice to form inside the

tower, removable screens will be provided to protect transmission lines from damage due to falling ice.

Provisions will be made via a hatch at the top of the Channel 41/47 aperture for access to external portions of the antenna to facilitate the rigging of a boatswain's chair for checking, repairing or replacing any exterior parts. Such access will be possible without the need to disassemble any component of the subject antenna, its feed harness, transmission line, or any other transmission lines.

Each pair of radiator panels is fed with a single feedline. A reflectometer well, with a gas-tight cover, will be provided in each line. A portable reflectometer will be supplied for insertion in any well to read VSWR.

The antenna will be designed for accessibility to all feed points. All joints ahead of the panel feed points will be accessible without substantial disassembly of the 41/47 feed system, and without disturbance of the feed system of any other antenna on the same tower. A fiberglass radome will completely enclose the antenna with a sectional design that will permit accessibility and removal of any panel for service. A sketch of the mechanical configuration of the antenna follows as Figure 1-41/47.

Electrical

The calculated vertical pattern is shown in Figure 3-41.

The calculated horizontal pattern is shown in Figure 4-41/47.

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 1-41.

Exceptions

Exceptions are being taken to the following requirements:

Paragraph 41 (7). In this paragraph a VSWR specification for the antenna alone is given. Due to the construction of the feed system (four input lines) and the fact that at no time is the antenna assembled in a form in which a composite measurement of this type can be made, no proof of compliance is practical. It is believed that the other measurements indicated under "Tests and Measurements" will adequately and effectively demonstrate proper operation of the antenna.

Paragraph 41 (6 and 10) A requirement is that each half of the antenna be separately operable. To obtain the optimum vertical patterns for the antenna operating as one total unit, the use of seven layers has been found necessary. The employment of either six or eight layers degrades these patterns. With this configuration, it thus becomes necessary to provide for emergency operation by a design which permits either four or three layers to be used. This is then the method chosen for proposal. Vertical patterns satisfactory for emergency

service are attainable for either portion of the antenna at either channel under these conditions without disturbing the primary patterns of the full aperture.

It should be pointed out that, conversely, excellent patterns can be obtained for equal halves of the antenna by the use of one more or one less layer, if initially engineered into the design. It must, however, be done at the expense of the combined total-aperture pattern, since all three are not simultaneously attainable.

Paragraph 41 (4) While conformance with the FCC rule on limitation of signal above the horizontal will be target of the design, it cannot be guaranteed. This rule is a carry-over from a period prior to the use of beam tilt. It is felt that a waiver will be obtainable on the basis that economical and practical attainment of an excellent vertical pattern, with desirable beam tilt, may involve the condition against which the rule is aimed. The fact that the energy lost at higher angles is small is regarded as a further mitigating factor.

Paragraph 41 (76) This paragraph calls for a VSWR measurement made at the output of the transmitter to be within certain limits. As this includes the filterplexer, switching components, and diplexing combiner, it is felt that while

compliance may be anticipated it cannot be guaranteed. Such a requirement will, however, be acceptable if the measurement is made from a point near the location where the transmission line leaves the transmitter room.

Paragraph 41 (11 and 11-b) This requirement could be interpreted to cover employment of the entire feed system during measurement of the vertical pattern. The method of measurement proposed and the complexity and unwieldy nature of the harness, make this impractical. Furthermore, the time involved in its complete assembly and disassembly at the time of test excessively penalizes completion of the installation phase at the site to a degree felt to be unacceptable. Since the approach proposed for the measurement insures the obtaining of the desired assurance of feed system and pattern integrity without resort to use of the whole system, exception is felt to be justified.

WXTV-TV - Channel 41

Auxiliary Equipment

A. Combiner/Switching

A non-resonant combiner is used to combine the signals of Channels 41 and 47 so that a diplexed antenna system may be used. The combiner is comprised of two waveguide 4-port hybrid couplers, two waveguide phasing loops, and a 2500 watt terminating load. The input signals of Channels 41 and 47 are fed separately into the input ports of one 4-port hybrid which is connected by unequal length waveguide sections to the second 4-port hybrid. The difference in length of these waveguide sections is chosen to provide the combined output of both channels at one output of the second 4-port hybrid coupler. The remaining port is terminated to absorb the unbalance power due to system tolerances.

Emergency bypass switching is provided in this system by manual means. The system installation will be designed so that bypass switching is conveniently achieved by removing certain system components and either placing them at a different orientation in the system or by replacing them with additional components supplied. See Figure 2-41/47. The following modes are thereby provided:

1) Normal diplexed use of entire antenna by both stations.

2) Emergency use of upper portion of antenna by one station and the lower portion by other station.

3) Emergency use of upper portion of antenna by both stations.

4) Emergency use of lower portion of antenna by both stations.

The combiner/switching will be designed for unpressurized service to permit bypass switching without depressurizing transmission line. This equipment should be located in the transmission line room or other controlled environment.

To assure that the -50 dB isolation requirement between Channels 41 and 47 is met, isolation traps will be included in the station input to the combiner. Isolation from all other antennas on World Trade Center Building is expected to be adequate.

The power handling capability of the combiner and transmission line feed system to the antenna is rated at 200% of normal power rating per channel to provide full power operation by both stations during emergency operation of the combined signals into one-half the antenna.

B. Bleeder Facilities

A bleeder line will be provided from the end of each transmission line into the transmitter room.

WXTV-TV - Channel 41

Tests and Measurements

I. Design Considerations Prior to Shipment

The antenna horizontal pattern will be determined from measurements of a single layer of the antenna. The measured layer will contain a broadband distribution network which has been previously developed and optimized for the specified horizontal pattern. Necessary fine adjustments in the layer network will be made to attain the patterns specified in the requirement, within a tolerance of $\pm$ 3 dB. Components in each other layer will be modified, if necessary, to correspond to the final network of the measured layer. Every layer will be completely assembled, impedance checked, and shipped to the erection site as a unit.

The vertical pattern of the antenna will be measured at picture carrier frequency using a single vertical column of seven panels driven by a special test feed system. The amplitude and phase of the individual panels will be compared to those of each other panel in the column, using a null detection method, employing probes in the transmission line at each feed point. Corrections in the relative values will be made to obtain and demonstrate compliance with the criteria set forth in Section 4 of the requirements. (Note exception taken on radiation above horizontal.)

Based upon the results obtained, the vertical transmission line complex will be completed and tested to insure the proper relative values in the successive complete layers of panels.

The horizontal and vertical pattern measurements will substantiate the specified vertical gain, horizontal gain, electrical beam tilt and null fill. Opportunity will be provided for witnessing of the tests by the Engineer.

The transmission line will be assembled , optimized for VSWR and reflected pulse, and matchmarked at the manufacturer's plant prior to shipment to the site.

Typical components of the 8-3/16 inch transmission line to the antenna will be demonstrated, using 60 Hz voltage to have ratings 200% of those that will obtain during operation with both channels into the full antenna at 110 kw peak visual and 22 kw aural.

II. Prior to Erection

Prior to installation on the World Trade Center Building, visual inspection will be made of the antenna and the transmission lines to make sure that no damage has occurred during shipment.

III. <u>During Erection</u>

A. DC pulse measurements of the 8-3/16 transmission line will be made during assembly to insure correct installation. This will be done at frequent intervals as the line is put in, using the standard method of rapping flanges with a rubber mallet at points of junction, to display the characteristic spasmodic jump of the pulse if a poor joint has been made. A specific value of return amplitude is not meaningful as certain portions of the system such as coaxial transformers and elbows are by nature narrow band, and therefore produce (correctly) pulse return indications at the 0-50 MHz frequencies contained in the test pulses. Locations where returns are questionable will be investigated.

B. Tests and measurements as deemed necessary will be made within and into the feed systems of the separate layers to provide assurance that electrical and mechanical conditions achieved during assembly at the Antenna Development Center are maintained.

IV. <u>After Erection</u>

A. Upon completion of installation of the antenna and its transmission line system, measurements of the phase and amplitude of each layer of panels relative to those of each other layer will be made using the method employed in the vertical pattern tests at the Development Center. Line

lengths and power divisions will be trimmed to duplicate the values obtained there.

B. VSWR measurements will be made at the output of the combiner looking into each transmission line terminated in a matching resistive load. It will be demonstrated that values obtained at 0.25 MHz intervals do not exceed 1.08 to 1 over the 6 MHz channel.

C. Each transmission line terminated in a matching load will be tested from the output of the combiner complex with an RF pulse of 0.25 micro-second in width and a repetition rate of approximately 15,750 pulses per second at visual carrier frequency. Any return pulse will be demonstrated to be below 2% of the outgoing pulse.

D. Measurements will be made with the RF pulse method specified in Paragraph "C" above of each transmission line terminated in its portion of the antenna. The system will be adjusted to provide minimum practicable pulse return, consistent with meeting the VSWR requirement in Paragraph "E" below, but in no event shall the pulse return be greater than 2.5% of the outgoing pulse.

E. VSWR measurements will be made at the point of entry into each of the four transmission lines from the combiner complex, with the related antenna portions connected at the upper end.

It will be demonstrated that the VSWR in each case does not exceed 1.1 at picture carrier and 1.15 at any other point in the 6 MHz channel.

F. VSWR measurements will be made at the wall of the transmitter room looking into each transmission line terminated in its related portion of the antenna to demonstrate that values obtained at 0.25 MHz intervals across the channel do not exceed 1.1 at picture carrier and color subcarrier, and 1.3 at other points within the 6 MHz band. Exception is taken to the requirement that this specification be met at the output of the transmitter.

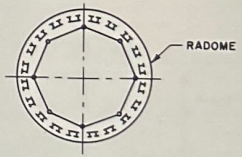
G. VSWR measurements will be made at the wall of the transmitter room, with the system "sectionalized" to feed the upper portion of the antenna, to demonstrate that the VSWR at picture carrier does not exceed 1.1 to 1.0. Corresponding measurements will be made of the lower portion of the antenna to show compliance with the same requirement.

H. Isolation measurements from Channel 47 and from the signals of the other TV stations in the array will be made at the wall of the transmitter room to demonstrate compliance with the 50 dB specification with respect to peak visual desired transmitter power. It is assumed that Channel 41 and the Engineer will cooperate in arranging to have the undesired channel operating at normal power during the course of the measurement.

I. The complete system will be pressurized to 10 lbs. and suitable measurements made to demonstrate that it does not leak more than 0.5 lb. of pressure in 48 hours.

J. Following completion of the array, measurements of the horizontal and vertical patterns of the antenna will be made by helicopter, as outlined under Appendix 12 of this proposal.

WNJU-TV/WXTV-TV
CHANNELS 47/41
MARK III DIPLEXED
MECHANICAL CONFIGURATION



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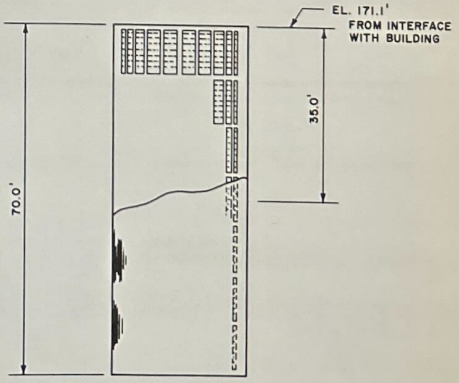


ELEVATION

FIGURE 1-41/47

EJB 700427-6
REV 5/4/70
REV 5/8/70

COMBINING SYSTEM
CHANNELS 41/47
MECHANICAL CONFIGURATION

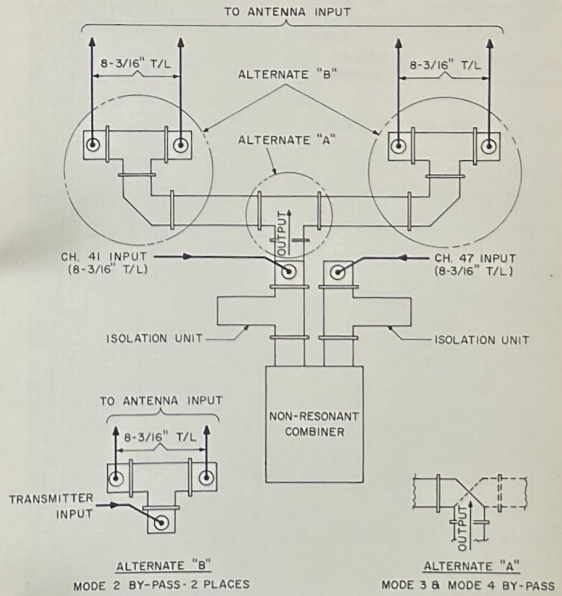


FIGURE 2-41/47

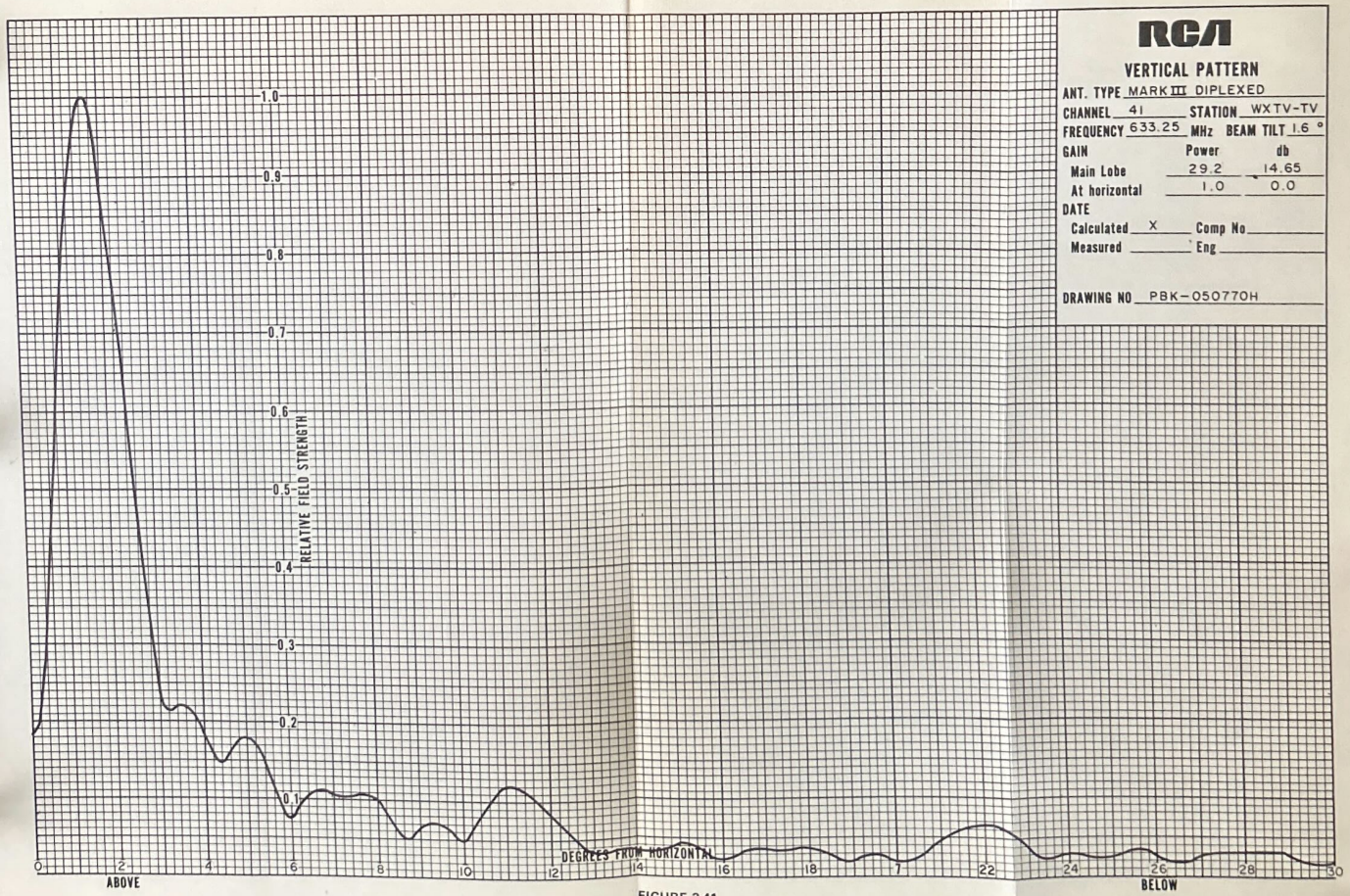

RCA
VERTICAL PATTERN
ANT. TYPE MARK III DIPLEXED
CHANNEL 41 STATION WXTV-TV
FREQUENCY 633.25 MHz BEAM TILT 1.6 °
GAIN Power db
Main Lobe 29.2 14.65
At horizontal 1.0 0.0
DATE
Calculated X Comp No
Measured Eng
DRAWING NO PBK-050770H
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
RELATIVE FIELD STRENGTH
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
DEGREES FROM HORIZONTAL
ABOVE
BELOW

FIGURE 3-41

RCA

VERTICAL PATTERN

ANT. TYPE MARK III DIPLEXED

CHANNEL 41 STATION WXTV-TV

FREQUENCY 633.25 MHz BEAM TILT 1.6 °

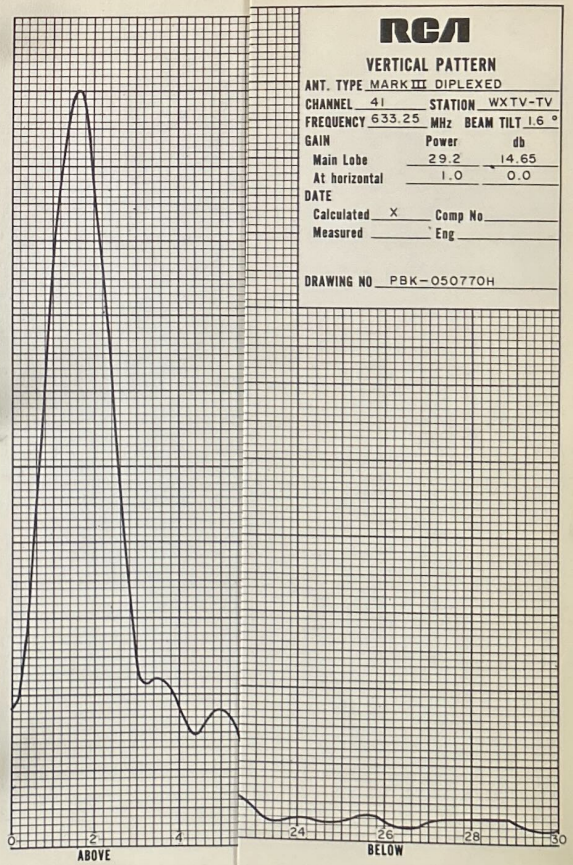
GAIN	Power	db
Main Lobe	29.2	14.65
At horizontal	1.0	0.0

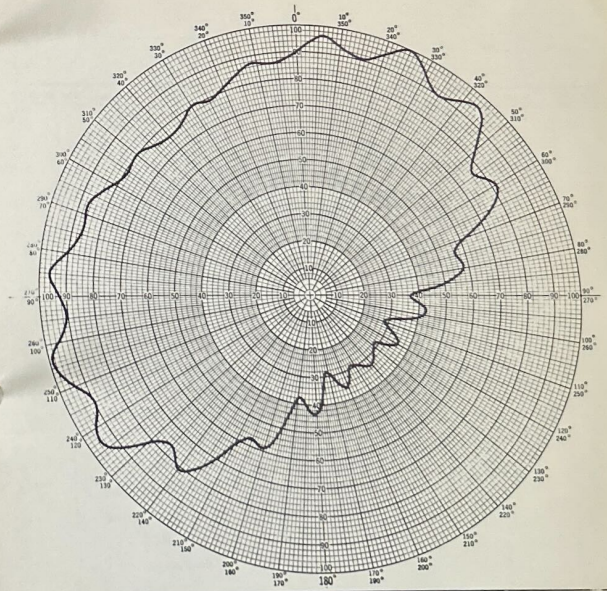
DATE

Calculated X Comp No

Measured Eng

DRAWING NO PBK-050770H





REMARKS	RCA
ANTICIPATED PATTERN	HORIZONTAL PATTERN
	ANT. TYPE MK III PANEL (DIPLEXED)
	CHANNEL 41/47 STATION WXTV-TV/
	LOCATION "WTC", N.Y.C. WNJU-TV
	FREQUENCY 635.25/ 669.25 MHz GAIN 1.88
	DATE
	Calculated Comp. No.
	Measured Eng.
FIGURE 4-41/47	DRAWING NO. DAB-012870-B

RCA No. _____ **SCHEDULE A** PAGE _____ OF _____

Table 2-41

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WXTV-TV - Channel 41		
				Transmission Line Requirements		
				Since Channels 41 and 47 will each have a single 8-3/16" line to the combiner, and the two stations will share four 8-3/16" lines between the combiner and the antenna, the single line and two of the four lines are covered below as Channel 41's share:		
		14	561566-D-1B	8 3/16 x 19' 6"		
		2	561566-D-9B	8 3/16 x 17' 0"		
		2	561566-D-9B	8 3/16 x 13' 0"		
		6	561566-D-9B	8 3/16 x 10' 0"		
		2	561566-D-9B	8 3/16 x 4' 6"		
		8	561566-D-2A/2B	Coupling 90° elbows		
		2	561566-D-3A	Gas stop		
		12	561569-40	Fixed hanger		
		28	561569-50	Expand. hanger		
		2	27701-special	Horizontal hanger kit		
		1	561569-48	Single wall anchor		

EOP 944

FILTER COMBINER

CHANNELS 41/47

ELECTRICAL CHARACTERISTICS

Isolation (From Opposite Channel)	33 dB (Alone) 50 dB (With traps)
Power Input (Each Channel)	110 KW (Each Channel)
Efficiency*	96.5%
VSWR* (Optimized with traps and switching components)	Pix 1.035 Color 1.035 Aural 1.07 Max. 1.12

*To be measured during development at manufacturers site.

TABLE 3-41/47

RCA

BROADCAST ANTENNA SPECIFICATION SUMMARY

Proposal No. 70-306-515 Date MAY 8, 1970 Revision _____

Station WXTV-TV Channel 41 Type MARK III DIPLEXED

Customer WORLD TRADE CENTER Location NEW YORK CITY

ELECTRICAL SPECIFICATIONS	VALUE	DB	UNITS	REMARKS
Vertical Power Gain, Main Lobe (Same as RMS Gain)	29.2	14.65	Ratio Over Dipole	
Vertical Power Gain at Horizontal	1.0	0.0	"	FOR 1.5° BEAM TILT DIRECTION
Horizontal Gain, Main Lobe	1.88	2.74	Area Ratio	
Directional Gain	54.8	17.39	Ratio Over Dipole	
Circularity	–	–	± From Avg. Circle	
Peak TV Power Capability (20% Aural)	200	–	KW	FOR CHANNEL 41
Beam Tilt (ELECTRICAL) (MECHANICAL) †	1.6 0.5	–	Degree(s)	†TOWARDS 140° TRUE
Input Line Size and MI No.	8 3/16	–	Inches	MI-561566-D – 4 LINES FOR BOTH CHANELLS
Input Characteristic Impedance	75	–	Ohms	
*SYSTEM INPUT SPECIFICATION	1.1:1.0 1.15:1.0	AT PIX REST OF BAND	VSWR (MAX)	6.2.5% RF PULSE – ALL AT COMBINER OUTPUT INTO 8 3/16" LINE

Vertical Pattern Dwg. No.	PBK-050770-H
Horizontal Pattern Dwg. No.	DAB-012870-B
Sketch No.	EJB-700427-6

MECHANICAL SPECIFICATIONS	VALUE	UNITS	REMARKS
Height with Lightning Protector (H_4)	–	Feet	
Height Over Tower Top (H_2)	70	Feet	
Height Center of Radiation (H_3)	136.1	Feet	FROM BUILDING INTERFACE
R_1 (Reaction)		Pounds	
D_1 (Moment Arm Above Base)		Feet	
Overturn Moment (Wind Load _____ PSF)		Foot Pounds	
Weight		Ton(s)	
*SYSTEM INPUT SPECIFICATION	1.1:1.0 1.3:1.0	VSWR	AT PIX AND COLOR REST OF BAND / AT TRANSMITTER ROOM WALL
*TRANSMISSION LINE INPUT SPECIFICATIONS	1.08:1.0	VSWR (MAX)	INTO MATCHING LOAD, EACH LINE

Prepared By: _____

Approved By: _____

Antenna Engineering Center
Gibbsboro, New Jersey
Commercial Electronic Systems Division

Form No. 8000766

TABLE 1-41

SECTION VII APPENDIX 10

Equipment Description	Page	1 - 6
Auxiliary Equipment		7 - 8
Tests and Measurements		9 -14
Antenna Sketch	Figure	1-41/47
Combiner Sketch		2-41/47
Vertical Pattern		3-47
Horizontal Pattern		4-41/47
Specification Summary	Table	1-47
Transmission Line Equipment List		2-47
Combiner Specifications		3-41/47

WNJU-TV

Channel 47

Equipment Description

The antenna proposed is a special cylindrical array of Mark III type panels mounted on a tower structure and designed for directional operation. It will occupy the space allocated for the joint use of Channels 41 and 47 below the Channel 2 and Channel 31 aperture. Channel 47 will share the same antenna with Channel 41 through diplexing circuitry.

Mechanical

The basic Mark III panel is a simplified arrangement of six broadband radiators of approximately one wavelength width. A balanced strip line is utilized to feed the radiators. The panels will be fed at the center from a single pressurized feed point. There will be seven vertical layers of panels with a maximum of twenty panels in each layer in the complete antenna system. The actual number of panels in a layer will be optimized during the horizontal pattern development carried out to meet the pattern specifications.

The antenna will be divided into two portions for emergency operation - a four-layer portion and a three-layer portion. The transmission line feed from the combiner/switching

equipment to each portion of the antenna will be parallel 8-3/16 inch universal type transmission lines for a total of four lines. The transmission line feed to the combiner/switching equipment from the transmitter room will be single 8-3/16 inch universal transmission lines rated at over 100% of the channel full power capability.

An estimate of transmission line required is given in Table 3-47. This list will be corrected to actuals after final layout and the price adjusted at that time to published list values.

Antenna will withstand without damage a wind pressure equivalent to that specified for Tower A Tower Support Structure.

Antenna feed lines, junction boxes and hardware will be constructed of materials suitable for continuous operation in marine environment. Copper outer conductors will be used for all feedlines. Steel components will be properly galvanized or of stainless steel. Junctions of dissimilar metals will be avoided or protected to prevent electrolysis.

Mechanical protection against falling ice will be provided by screens above the radome or by other methods. All pattern and impedance tests will be made with ice protectors in place. If the structure permits ice to form inside the

tower, removable screens will be provided to protect transmission lines from damage due to falling ice.

Provisions will be made via a hatch at the top of the Channel 41/47 aperture for access to external portions of the antenna to facilitate the rigging of a boatswain's chair for checking, repairing or replacing any exterior parts. Such access will be possible without the need to disassemble any component of the subject antenna, its feed harness, transmission line, or any other transmission lines.

Each pair of radiator panels is fed with a single feedline. A reflectometer well, with a gas-tight cover, will be provided in each line. A portable reflectometer will be supplied for insertion in any well to read VSWR.

The antenna will be designed for accessibility to all feed points. All joints ahead of the panel feed points will be accessible without substantial disassembly of the 41/47 feed system, and without disturbance of the feed system of any other antenna on the same tower. A fiberglass radome will completely enclose the antenna with a sectional design that will permit accessibility and removal of any panel for service. A sketch of the mechanical configuration of the antenna follows as Figure 1-41/47.

Electrical

The calculated vertical pattern is shown in Figure 3-47.

The calculated horizontal pattern is shown in Figure 4-41/47.

Specifications

A summary of the mechanical and electrical specifications proposed is shown in Table 1-47.

Exceptions

Exceptions are being taken to the following requirements:

Paragraph 41 (7). In this paragraph a VSWR specification for the antenna alone is given. Due to the construction of the feed system (four input lines) and the fact that at no time is the antenna assembled in a form in which a composite measurement of this type can be made, no proof of compliance is practical. It is believed that the other measurements indicated under "Tests and Measurements" will adequately and effectively demonstrate proper operation of the antenna.

Paragraph 41 (6 and 10) A requirement is that each half of the antenna be separately operable. To obtain the optimum vertical patterns for the antenna operating as one total unit, the use of seven layers has been found necessary. The employment of either six or eight layers degrades these patterns. With this configuration, it thus becomes necessary to provide for emergency operation by a design which permits either four or three layers to be used. This is then the method chosen for proposal. Vertical patterns satisfactory for emergency

service are attainable for either portion of the antenna at either channel under these conditions without disturbing the primary patterns of the full aperture.

It should be pointed out that, conversely, excellent patterns can be obtained for equal halves of the antenna by the use of one more or one less layer, if initially engineered into the design. It must, however, be done at the expense of the combined total-aperture pattern, since all three are not simultaneously attainable.

Paragraph 41 (4) While conformance with the FCC rule on limitation of signal above the horizontal will be target of the design, it cannot be guaranteed. This rule is a carry-over from a period prior to the use of beam tilt. It is felt that a waiver will be obtainable on the basis that economical and practical attainment of an excellent vertical pattern, with desirable beam tilt, may involve the condition against which the rule is aimed. The fact that the energy lost at higher angles is small is regarded as a further mitigating factor.

Paragraph 41 (76) This paragraph calls for a VSWR measurement made at the output of the transmitter to be within certain limits. As this includes the filterplexer, switching components, and diplexing combiner, it is felt that while

compliance may be anticipated it cannot be guaranteed. Such a requirement will, however, be acceptable if the measurement is made from a point near the location where the transmission line leaves the transmitter room.

Paragraph 41 (11 and 11-b) This requirement could be interpreted to cover employment of the entire feed system during measurement of the vertical pattern. The method of measurement proposed and the complexity and unwieldy nature of the harness, make this impractical. Furthermore, the time involved in its complete assembly and disassembly at the time of test excessively penalizes completion of the installation phase at the site to a degree felt to be unacceptable. Since the approach proposed for the measurement insures the obtaining of the desired assurance of feed system and pattern integrity without resort to use of the whole system, exception is felt to be justified.

Auxiliary Equipment

A. Combiner/Switching

A non-resonant combiner is used to combine the signals of Channels 41 and 47 so that a diplexed antenna system may be used. The combiner is comprised of two waveguide 4-port hybrid couplers, two waveguide phasing loops, and a 2500 watt terminating load. The input signals of Channels 41 and 47 are fed separately into the input ports of one 4-port hybrid which is connected by unequal length waveguide sections to the second 4-port hybrid. The difference in length of these waveguide sections is chosen to provide the combined output of both channels at one output of the second 4-port hybrid coupler. The remaining port is terminated to absorb the unbalance power due to system tolerances.

Emergency bypass switching is provided in this system by manual means. The system installation will be designed so that bypass switching is conveniently achieved by removing certain system components and either placing them at a different orientation in the system or by replacing them with additional components supplied. See Figure 2-41/47. The following modes are thereby provided:

1) Normal diplexed use of entire antenna by both stations.

2) Emergency use of upper portion of antenna by one station and the lower portion by other station.

3) Emergency use of upper portion of antenna by both stations.

4) Emergency use of lower portion of antenna by both stations.

The combiner/switching will be designed for unpressurized service to permit bypass switching without depressurizing transmission line. This equipment should be located in the transmission line room or other controlled environment.

To assure that the -50 dB isolation requirement between Channels 41 and 47 is met, isolation traps will be included in the station input to the combiner. Isolation from all other antennas on World Trade Center Building is expected to be adequate.

The power handling capability of the combiner and transmission line feed system to the antenna is rated at 200% of normal power rating per channel to provide full power operation by both stations during emergency operation of the combined signals into one-half the antenna.

B. Bleeder Facilities

A bleeder line will be provided from the end of each transmission line into the transmitter room.

WNJU-TV - Channel 47

Tests and Measurements

I. Design Considerations Prior to Shipment

The antenna horizontal pattern will be determined from measurements of a single layer of the antenna. The measured layer will contain a broadband distribution network which has been previously developed and optimized for the specified horizontal pattern. Necessary fine adjustments in the layer network will be made to attain the patterns specified in the requirement, within a tolerance of $\pm$ 3 dB. Components in each other layer will be modified, if necessary, to correspond to the final network of the measured layer. Every layer will be completely assembled, impedance checked, and shipped to the erection site as a unit.

The vertical pattern of the antenna will be measured at picture carrier frequency using a single vertical column of seven panels driven by a special test feed system. The amplitude and phase of the individual panels will be compared to those of each other panel in the column, using a null detection method, employing probes in the transmission line at each feed point. Corrections in the relative values will be made to obtain and demonstrate compliance with the criteria set forth in Section 4 of the requirements. (Note exception taken on radiation above horizontal.)

Based upon the results obtained, the vertical transmission line complex will be completed and tested to insure the proper relative values in the successive complete layers of panels.

The horizontal and vertical pattern measurements will substantiate the specified vertical gain, horizontal gain, electrical beam tilt and null fill. Opportunity will be provided for witnessing of the tests by the Engineer.

The transmission line will be assembled , optimized for VSWR and reflected pulse, and matchmarked at the manufacturer's plant prior to shipment to the site.

Typical components of the 8-3/16 inch transmission line to the antenna will be demonstrated, using 60 Hz voltage to have ratings 200% of those that will obtain during operation with both channels into the full antenna at 110 kw peak visual and 22 kw aural.

II. Prior to Erection

Prior to installation on the World Trade Center Building, visual inspection will be made of the antenna and the transmission lines to make sure that no damage has occurred during shipment.

III. <u>During Erection</u>

A. DC pulse measurements of the 8-3/16 transmission line will be made during assembly to insure correct installation. This will be done at frequent intervals as the line is put in, using the standard method of rapping flanges with a rubber mallet at points of junction, to display the characteristic spasmodic jump of the pulse if a poor joint has been made. A specific value of return amplitude is not meaningful as certain portions of the system such as coaxial transformers and elbows are by nature narrow band, and therefore produce (correctly) pulse return indications at the 0-50 MHz frequencies contained in the test pulses. Locations where returns are questionable will be investigated.

B. Tests and measurements as deemed necessary will be made within and into the feed systems of the separate layers to provide assurance that electrical and mechanical conditions achieved during assembly at the Antenna Development Center are maintained.

IV. <u>After Erection</u>

A. Upon completion of installation of the antenna and its transmission line system, measurements of the phase and amplitude of each layer of panels relative to those of each other layer will be made using the method employed in the vertical pattern tests at the Development Center. Line

lengths and power divisions will be trimmed to duplicate the values obtained there.

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F. VSWR measurements will be made at the wall of the transmitter room looking into each transmission line terminated in its related portion of the antenna to demonstrate that values obtained at 0.25 MHz intervals across the channel do not exceed 1.1 at picture carrier and color subcarrier, and 1.3 at other points within the 6 MHz band. Exception is taken to the requirement that this specification be met at the output of the transmitter.

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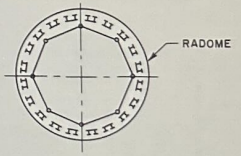
I. The complete system will be pressurized to 10 lbs. and suitable measurements made to demonstrate that it does not leak more than 0.5 lb. of pressure in 48 hours.

J. Following completion of the array, measurements of the horizontal and vertical patterns of the antenna will be made by helicopter, as outlined under Appendix 12 of this proposal.

WNJU-TV/WXTV-TV
CHANNELS 47/41
MARK III DIPLEXED
MECHANICAL CONFIGURATION



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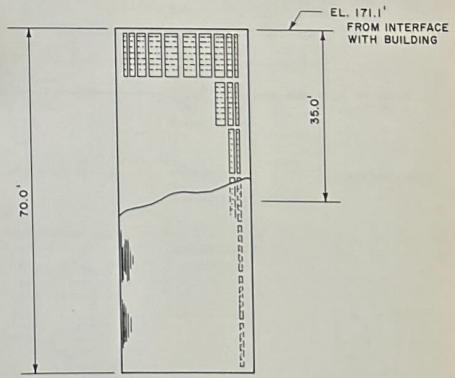
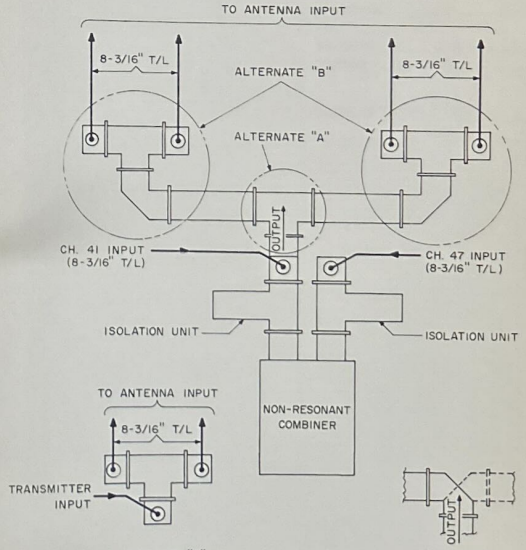


ELEVATION

FIGURE 1-41/47

EJB 700427-6
REV 5/4/70
REV 5/8/70

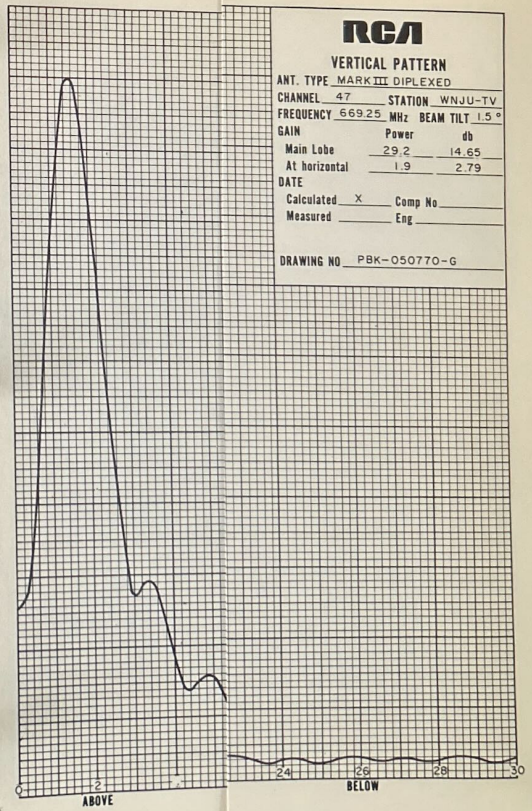
COMBINING SYSTEM
CHANNELS 41/47
MECHANICAL CONFIGURATION



ALTERNATE "B"
MODE 2 BY-PASS - 2 PLACES

ALTERNATE "A"
MODE 3 & MODE 4 BY-PASS

FIGURE 2-41/47



RCA

VERTICAL PATTERN

ANT. TYPE MARK III DIPLEXED

CHANNEL 47 STATION WNJU-TV

FREQUENCY 669.25 MHz BEAM TILT 1.5°

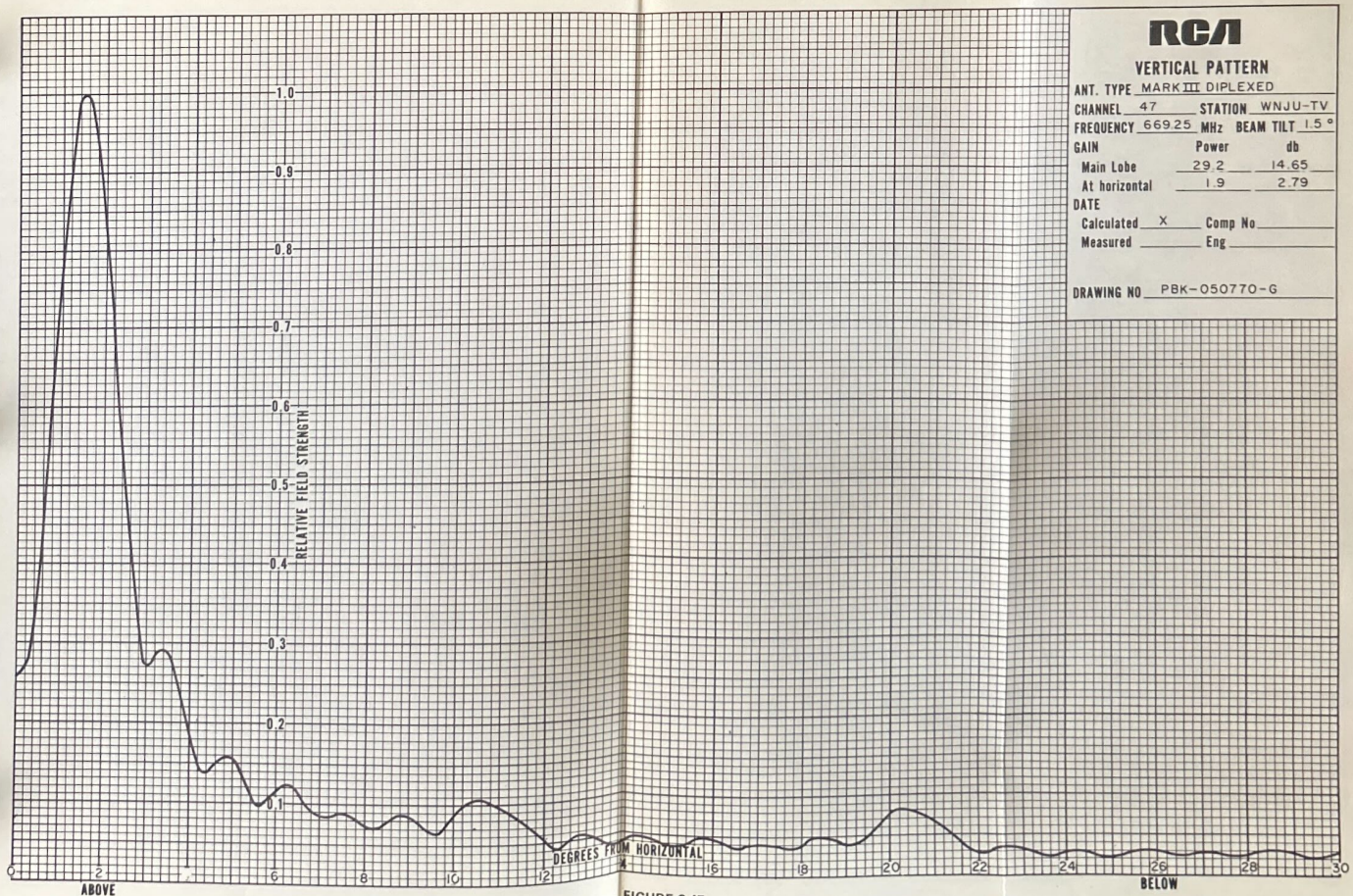
GAIN	Power	db
Main Lobe	29.2	14.65
At horizontal	1.9	2.79

DATE

Calculated X Comp No

Measured Eng

DRAWING NO PBK-050770-G


RCA
VERTICAL PATTERN
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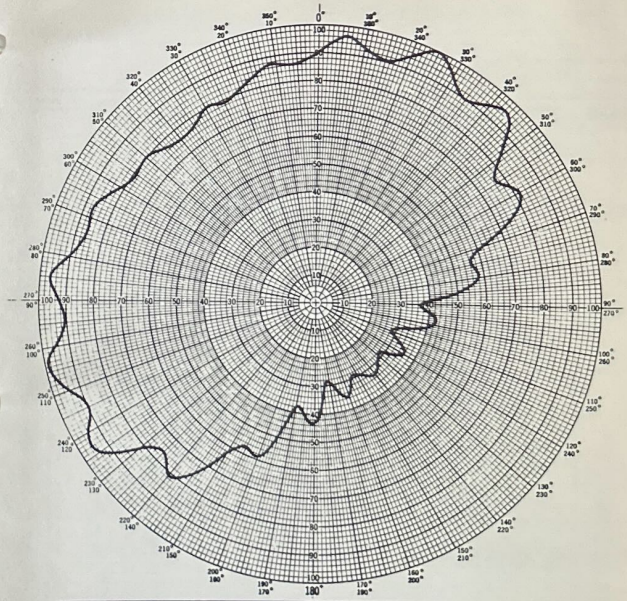
CHANNEL 47 STATION WNJU-TV
FREQUENCY 669.25 MHz BEAM TILT 1.5°
GAIN Power db
Main Lobe 29.2 14.65
At horizontal 1.9 2.79
DATE
Calculated X Comp No
Measured Eng
DRAWING NO PBK-050770-G
RELATIVE FIELD STRENGTH
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2
6
8
10
12
16
18
20
22
24
26
28
30
DEGREES FROM HORIZONTAL
ABOVE
BELOW

FIGURE 3-47



REMARKS	RCA
ANTICIPATED PATTERN	HORIZONTAL PATTERN
	ANT. TYPE MK III PANEL (DIPLEXED)
	CHANNEL 41/47 STATION WXTV-TV/
	LOCATION "WTC", N.Y.C. WNJU-TV
	FREQUENCY 635.25/ 665.25 MHz GAIN 1.88
	DATE
	Calculated Comp. No.
	Measured Eng.
FIGURE 4-41/47	DRAWING NO. DAB-012870-B

RCA No. _____

SCHEDULE A

Table 2-47

PAGE _____ OF _____

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				WNJU-TV - Channel 47		
				Transmission Line Requirements		
				Since Channels 41 and 47 will each have a single 8-3/16" line to the combiner, and the two stations will share four 8-3/16" lines between the combiner and the antenna, the single line and two of the four lines are covered below as Channel 47's share.		
		18	561566-D-1A	8 3/16 x 20' 0"		
		2	561566-D-99	8 3/16 x 19' 0"		
		2	561566-D-99	8 3/16 x 17' 0"		
		4	561566-D-99	8 3/16 x 8' 0"		
		16	561566-D-2A/2B	Coupling 90° elbows		
		2	561566-D-3A	Gas stop		
		10	561569-40	Fixed hanger		
		26	561569-50	Expand. hanger		
		6	27701 special	Horiz. hanger		
		1	561569-48	Wall anchor		

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FILTER COMBINER

CHANNELS 41/47

ELECTRICAL CHARACTERISTICS

Isolation (From Opposite Channel)	33 dB (Alone) 50 dB (With traps)
Power Input (Each Channel)	110 KW (Each Channel)
Efficiency*	96.5%
VSWR* (Optimized with traps and switching components)	Pix 1.035 Color 1.035 Aural 1.07 Max. 1.12

*To be measured during development at manufacturers site.

TABLE 3-41/47

SECTION VII APPENDIX 11

Equipment Description	Page	1-4
Auxiliary Equipment		5-6
Tests and Measurements		7-8
Antenna Sketch	Figure	1-FM
Antenna and Switching Lines		2-FM
Multiplexer and Emergency		3-FM
Specification Summary	Table	1-FM
Transmission Line Equipment List		2-FM

FM Master Antenna

Equipment Description

The multiple station FM antenna proposed for the World Trade Center consists of two layers of BFF panel radiators as shown in Figure 1-FM. Each antenna layer is made up of four individual BFF panel radiators affixed to the faces of the square supporting tower structure.

The array is designed for omnidirectional operation. With its combiner system, it will accomodate seven FM stations, as follows:

WNYC-FM	93.9 MHz
WABC-FM	95.5 MHz
WNBC-FM	97.1 MHz
WOR-FM	98.7 MHz
WCBS-FM	101.1 MHz
WPIX-FM	101.9 MHz
WNEW-FM	102.7 MHz

Mechanical

The BFF panel radiator is a circularly polarized broadband radiator consisting of two diagonally crossed dipoles rigidly supported in front of a reflecting screen. Appropriate structural members are provided to attach the reflecting screen to the supporting tower face. Mechanical specifications are shown on the "Broadcast Antenna Specification Summary," shown as Table 1-FM.

Each layer of the antenna is fed separately by a pair of quadrature phased 3 1/8 inch MI-27791-D transmission lines. The four lines will run from the antenna to the station combining

system, located in the Building, through switching which permits emergency operation. (described below).

A schematic diagram of this portion of the system is shown in Figure 2-FM.

A combiner system, incorporating means to remove individual elements from the circuit in the event of emergency, feeds the quadrature coupler with the combined signals of all stations, as diagrammed in Figure 3-FM. The filter components used in the system are:

	Quantity
Notch Combiner, or Notch Diplexer	2
Tee Combiner, 2 narrow band inputs, each	3
Two hybrid combiner with runout loop	1

Inputs from the various stations are by means of 3 1/8" MI 27791-D (Universal) transmission lines supplied under this proposal to the walls of the several transmitter rooms.

An estimated list of transmission line requirements, both in the part of the system common to all and in the individual runs to the stations, is shown in Table 2-FM. The quantities will be corrected to actual upon final layout and the price thereof revised at that time in accord with published list values.

Electrical

The electrical characteristics of the antenna are shown in Table 1-FM.

It should be noted that the 20 MHz bandwidth of the radiators makes for stable impedance and pattern characteristics.

A power gain of .92 for each polarization will be provided across the entire FM broadcast band.

The Multiplexer system described above is arranged to provide optimum performance for the stations being served. The location of each input has been chosen for best overall efficiency consistent with the frequency separation between channels.

The Tee Combiners are conventional two-input, one-output devices, composed of two notching filters (one for each input frequency) and a combining tee. For the two input signals involved, the device has high isolation (greater than 40 dB) low VSWR (1.04 or better into a matched load), and good efficiency (96.5%). Rated power is 5 KW each input.

The Two-Hybrid Combiner is a device composed of two hybrids, two unequal lengths of transmission line, and an absorbing resistor. The difference between the two lengths of transmission line is such that proper combining occurs due to phase difference only. No resonant elements are used. This device has two inputs which are broadband to accept the outputs of two of the tee combiners. For the four input signals involved, the device has high isolation (greater than 40 dB), VSWR (1.04 or better into matched loads) and good efficiency (96.5% and better). Rated power input is four signals at 5 KW each.

The "Notch" combiner (Notch Diplexer) has a broadband input for the four frequencies already discussed. It also has a notching input which notches two additional signals into the system. These two are previously combined in a third tee combiner. The output of this notch combiner feeds to the quadrature coupler in the antenna system. The unit has isolations up to 40 dB, input VSWR of 1.1 into match loads, and efficiencies of 96% and better. 30 KW is total average

input power.

The seventh station, WPIX, is fed into the system through the notch combiner shown. This combiner also provides a broadband port which any of the other stations can use in an emergency. The worst case efficiency for emergency operation through this unit is 88%. The WPIX efficiency is 93%. Input VSWR's are 1.1 or better, into a matched load.

The notch diplexers and tee combiners will include integral forced air cavity cooling. All cavities will be temperature compensated, commensurate with the expected environment, for good frequency stability.

Worst case efficiency through the multiplexer system for normal operation is 90%. Traps will be used as required to assure crosstalk between FM inputs to the system is greater than 45 dB for all stations participating in the system. Crosstalk between TV station and other FM inputs is expected to be greater than 45 dB.

The FM Antenna Power Gain, including the effects of the Antenna Transmission Line Loss and the worst case combining filter loss in normal operation will be .81. Transmitter power for 3.63 KW ERP will be 4.94 KW with a Station Transmission Line efficiency of .91.

Auxiliary Equipment

A. Antenna Switching

By utilizing a separate quadrature feed to each antenna layer, a convenient means of operating either antenna layer separately during emergency is afforded. The proposed emergency by-pass system is shown as Figure 2-FM. The four manual transfer switches and the two Tees shown allow either layer of the antenna to be operated separately by manually operating two switches. The switching system will be gassed from the transmission line system.

B. Combiner Switching

Switching shown as part of the combining system allows participants to continue broadcasting on an emergency basis in the event that one of the units in the system becomes inoperative. This switching is pressurized as part of the combiner systems and is operable without depressurizing the system.

C. Monitor and Interlock Facilities

Each of the 3 1/8 outputs of the quadrature coaxial coupler will contain an RF power monitor alarm unit which will provide protection from the effects of excessive antenna or antenna transmission line VSWR. Contacts will be provided to shut down transmitters.

Each combiner input will contain an RF power monitor alarm unit which will provide an interlock to turn off the particular transmitter if VSWR increases due either to off-carrier components of the transmitter or failures in the combiner.

D. Dehydrator and Bleeding Facilities

The antenna, transmission lines, and combiners are pressurized with dry air to keep inner surfaces of components clean and dry. Each FM station transmission line is provided with two gas barriers; one inside the transmitter room and one near the input to the FM combiner unit. One MI-563170-1 dehydrator will be supplied for the entire system. Each station transmission line will be capable of being depressurized without removing pressure from the rest of the system.

Exceptions

The feed system of the antenna consists of four 3 1/8 inch coaxial transmission lines instead of two 6 1/8 inch lines specified in the bid request. This is necessitated by the use of coaxial coupler method of feeding.

The pattern measurement of a complete model, as specified in the bid request, will not be made. However, pattern measurement of a single layer model will provide all necessary information of the performance of the antenna.

Test and Measurements

I. Design Considerations Prior to Shipment

Antenna parameters such as gain, pattern circularity, and vertical pattern shape will be measured using a single layer precision scale model. Past experience using precision model measurements show that a very close correlation exists between this data and that measured using the full scale actual antenna.

The filter system efficiency will be measured prior to shipment. Overall system gain per FM station will then be calculated using the above antenna gain, the measured filter efficiency, and the published transmission line efficiency. The overall antenna power gain using these calculations will be demonstrated to be greater than 0.8, not including the Station Transmission System. Using this data it will be demonstrated by calculation that the specified ERP will be achieved.

Values of decoupling or Isolation Filter loss, Antenna power gain, and station transmission line loss will be provided to each FM channel for construction permit filing purposes.

II. Prior to Erection

Prior to erection of the antenna and filter system a visual inspection of the various units will be made. This inspection will determine if shipping damage has occurred and will verify the completeness of the system prior to installation.

III. During Installation

During installation a DC pulse test will be made on each individual transmission line as it is installed in the system.

In this manner it is possible to detect and correct any anomaly at the time of installation.

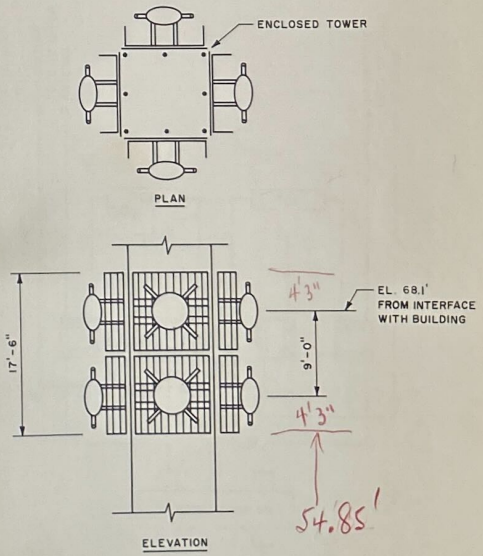
Pressurization checks will be made on the transmission line installations to assure an air tight system. Uncompleted installations will be capped and pressurized at the end of each day, and checked at the beginning of the next work day to verify system tightness. Completed transmission line runs will remain gassed to check for leakage.

IV After Erection

After installation of the FM System, on site compliance test will be made to demonstrate the decoupling from FM & TV stations and the input impedance of each individual FM station. The transmission line connecting the transmitter to the filter system will be optimized on site as required to demonstrate compliance with the input impedance specification.

Helicopter measurements will be made at the WOR carrier frequency (98.7 MHz), to show conformance with the patterns measured and calculated at the RCA Antenna Development Center.

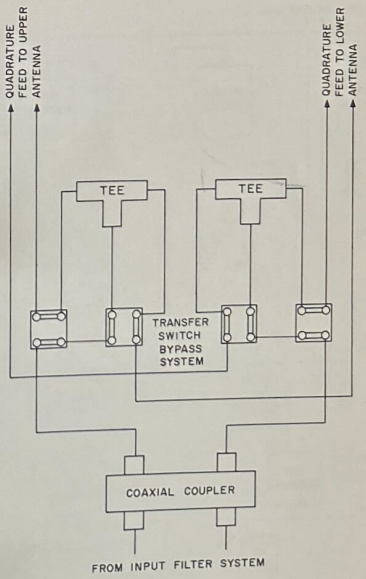
FM ANTENNA



EJB-700427-1

FIGURE 1-FM

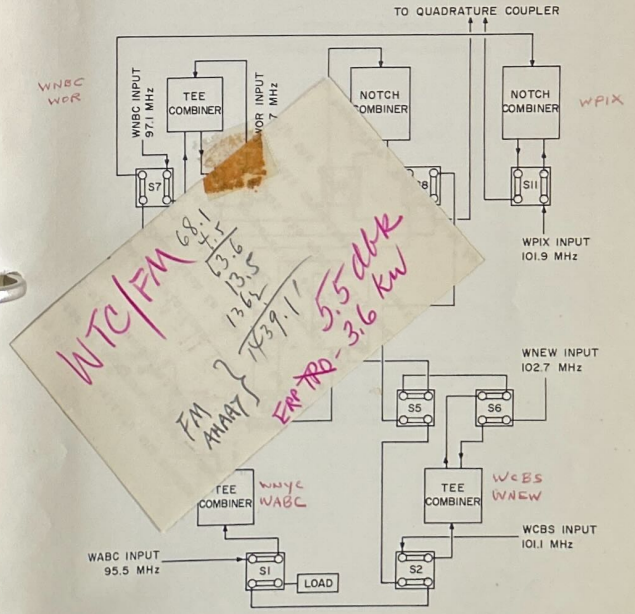
ANTENNA SWITCHING
MULTIPLE FM ANTENNA SYSTEM



REW 700502-1

FIGURE 2-FM

MULTIPLXER AND EMERGENCY SWITCHING
MULTIPLE FM ANTENNA SYSTEM



WTC/FM 68.1
4.5
13.6
13.5
1362
FM ARRAY } 1439.1'
5.5 dBk
ERP TRD - 3.6 kW

FIGURE 3-FM

WTC/FM 68.1
4.5
63.6
13.5
1362
1439.1

FM AMAAT } 5.5 dbk
ERP TRQ - 3.6 kW

MULTIPLXER AND EMERGENCY SWITCHING
MULTIPLE FM ANTENNA SYSTEM

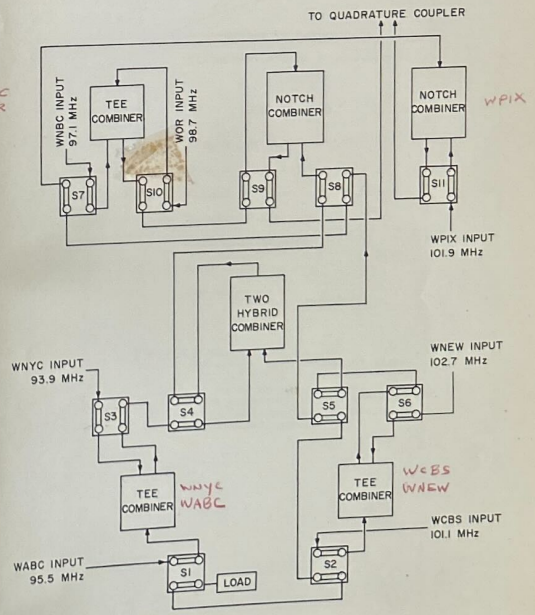


FIGURE 3-FM

ch other's beliefs and engaged
ries of programs would be amus
d will among citizens.

ublic relations--------Miss A
gram which is designed to hel
nt section of the city, Rive
has a wonderful blueprint for
ers, cooperative efforts with
and that the entire city wou
ow this organization is meet
elp the city.

l, executive, The American As

MULTIPLXER AND EMERGENCY SWITCHING
MULTIPLE FM ANTENNA SYSTEM

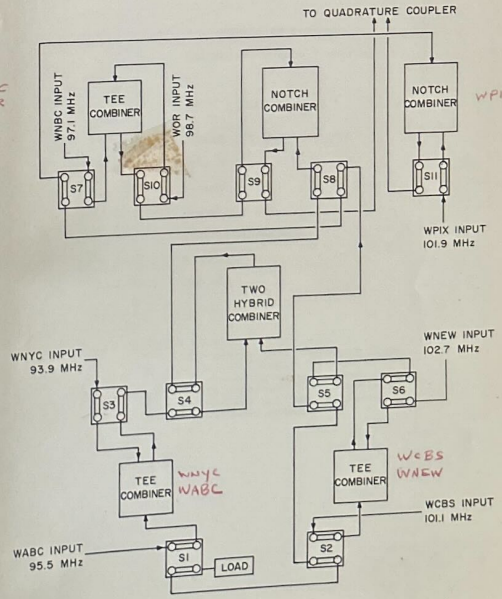


FIGURE 3-FM

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Table 2-FM

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				Master FM Antenna		
				Transmission Line Requirements		
				<u>Common Lines</u>		
		12	27791-D-1A	T/L, 3 1/8 x 20' = 240'		
		4	27791-D-99	T/L, 3 1/8 x 12' = 48'		
		4	27791-D-2A/B	Elbows		
		8	19313-44	Fixed hangers		
		20	19313-32	Expansion hangers		
		4	27791-D-4B	Adaptor		
		4	27791-D-3A	Gas stop		
				PLEASE NOTE: The transmission line component items above comprise those components commonly shared by all stations between the combiner and the antenna, and as such have not been allocated to any individual station.		

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Table 2-FM

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				Master FM Antenna		
				Transmission Line Requirements		
				WCBS-FM		
		2	27791-D-3A	Gas stop		
		4	27791-D-1A	T/L, 3 1/8 x 20'		
		3	27791-D-99	T/L, 3 1/8 x 10'		
		5	27791-2A/B	Elbows		
		1	27791-D-4B	Adaptor		

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Table 2-FM

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				Master FM Antenna		
				Transmission Line Requirements		
				WNYC-FM		
		2	27791-D-3A	Gas stop		
		6	27791-D-1A	T/L, 3 1/8 x 20'	120'	
		5	27791-D-99	T/L, 3 1/8 x 10'	50'	
		2	27791-D-2A/B	Elbow		
		1	27791-D-4B	Adaptor		
					170'	

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Table 2-FM

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				Master FM Antenna		
				Transmission Line Requirements		
				WNBC-FM		
		2	27791-D-3A	Gas stop		
		4	27791-D-1A	T/L, 3 1/8 x 20'		
		3	27791-D-99	T/L, 3 1/8 x 10'		
		5	27791-2A/B	Elbows		
		1	27791-D-4B	Adaptor		

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Table 2-FM

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				Master FM Antenna		
				Transmission Line Requirements		
				WNEW-FM		
		2	27791-D-3A	Gas stop		
		6	27791-D-1A	T/L, 3 1/8 x 20'		
		6	27791-D-99	T/L, 3 1/8 x 10'		
		7	27791-D-2A/B	Elbow		
		1	27791-D-4B	Adaptor		

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Table 2-FM

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				Master FM Antenna		
				Transmission Line Requirements		
				WABC-FM		
		2	27791-D-3A	Gas stop		
		5	27791-D-1A	T/L, 3 1/8 x 20'		
		4	27791-D-99	T/L, 3 1/8 x 10'		
		2	27791-D-2A/B	Elbow		
		1	27791-D-4B	Adaptor		

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Table 2-FM

MINOR	ITEM	QUAN.	M.I.	DESCRIPTION AND UNIT PRICE	AMOUNT	ESTIMATED DEL. DATE
				Master FM Antenna		
				Transmission Line Requirements		
				WOR-FM		
		2	27791-D-3A	Gas stop		
		2	27791-D-1A	T/L, 3 1/8 x 20'		
		5	27791-D-99	T/L, 3 1/8 x 10'		
		2	27791-D-2A/B	Elbow		
		1	27791-D-4B	Adaptor		

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RCA PROPOSAL BC-02636

SECTION VII

HELICOPTER MEASUREMENTS

VII. SPECIFICATIONS

F. Helicopter Measurements

Helicopter measurements will be made of the performance of the main antennas of the following stations:

WCBS-TV	Channel 2
WABC-TV	Channel 7
WOR-TV/WNDT-TV	Channels 9/13
WPIX-TV	Channel 11
WNYC-TV	Channel 31
WXTV/WNJU-TV	Channels 41/47

Measurements will also be made of the pattern of the FM antenna while it is operating on 98.7 MHz. (WOR frequency)

The procedure governing the taking of these measurements will be that set forth in Addendum 3, Paragraph 43, of the request for proposal. In accord with that procedure, RCA submits the following names of consulting engineers acceptable to RCA:

Kear and Kennedy Consulting Engineers
1302 18th St. N. W.
Washington, D. C. 20036

Paul Godley Co., Consulting Engineers
P. O. Box 798
Upper Montclair, N. J. 07043

A. D. Ring and Associates, Consulting Engineers
1771 N. St. N. W.
Suite 402
Washington, D. C. 20036

It is understood that RCA, if it is the successful bidder on this contract, will contract with the consulting engineer chosen from the above list by the Authority, and will be responsible for the performance of the services.

RCA proposes, based upon the recommendations submitted by the consultants above, to make a number of "passes" per station (the number to be chosen by the Consultant) in the horizontal plane at the height of the antenna. These passes will be at a uniform distance (chosen by the Consultant) from the antenna and around as much of a circle as will be permitted by air traffic regulations. Vertical plane measurements will be made in directions determined by the Consultant by means of helicopter drops for each station.

Repetition of passes or drops required in the opinion of the Consultant to obtain valid data will be at RCA's expense. The cost of additional runs or drops, if any, requested by the Authority or the Broadcasters, if not deemed necessary by the Consultant to obtain valid results, shall be borne by the Authority.

A premise on which the prices are based is that the helicopter measurements are to be made after completion of installation and turnover to the Authority, but within a period of three months therefrom. Further, that the Authority and the individual Broadcasters will cooperate with the Consultant in providing

adequate signal at such times as are practical for the flying of the aircraft and the taking of the measurements.